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PAGE 60

WATCH OUT, MR. SCHICKLEGRUBER! THE BOMBER FLOODS ARE COMING

SEE PAGE 78

THIS COMPLETE, SIMPLE, PRACTICAL COURSE FOR SELF-INSTRUCTION WILL QUICKLY GIVE YOU

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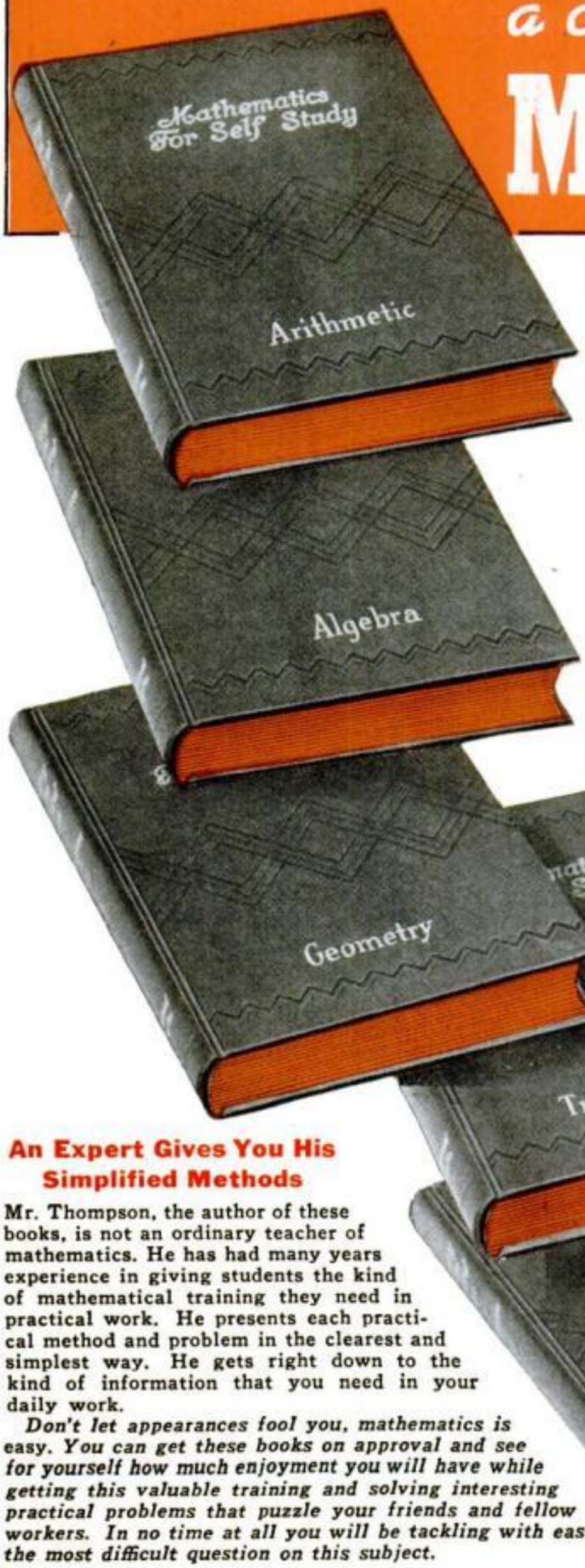

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(Continued on next page)

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(Continued from facing cover)

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Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

CONTENTS *for* MAY, 1943

Cover: Kodachrome by Harold Kulick

News

Automobiles

Home and Workshop

(Contents continued on page 4)

NEMESIS OF AIR POWER. This Navy antiaircraft-gun co-ordinator is one of the men who, on sea and land, are challenging the airplane's claim to dominance in war. In an article on page 66, Allen Raymond tells how more and better guns are providing an answer to air power.

Published monthly at 353 Fourth Avenue, New York, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Vice-Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

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Contents [CONTINUED]

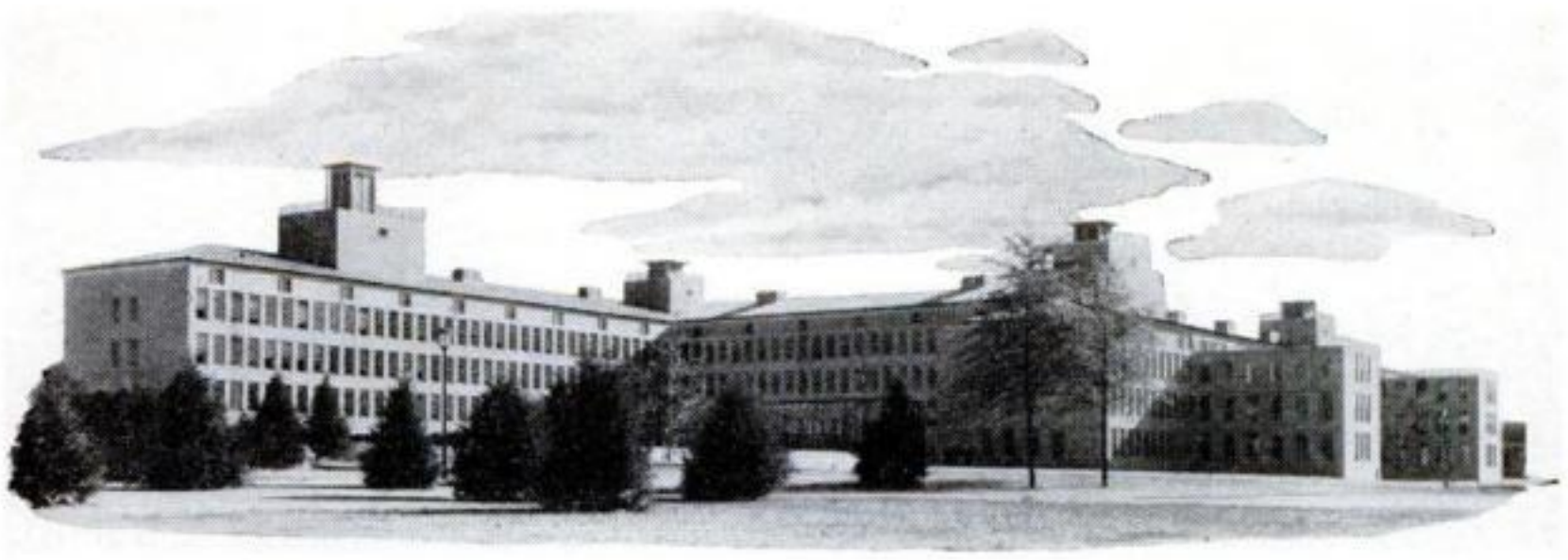
Aviation

Facts and Ideas

Inventions

Photography

(Contents continued on page 6)



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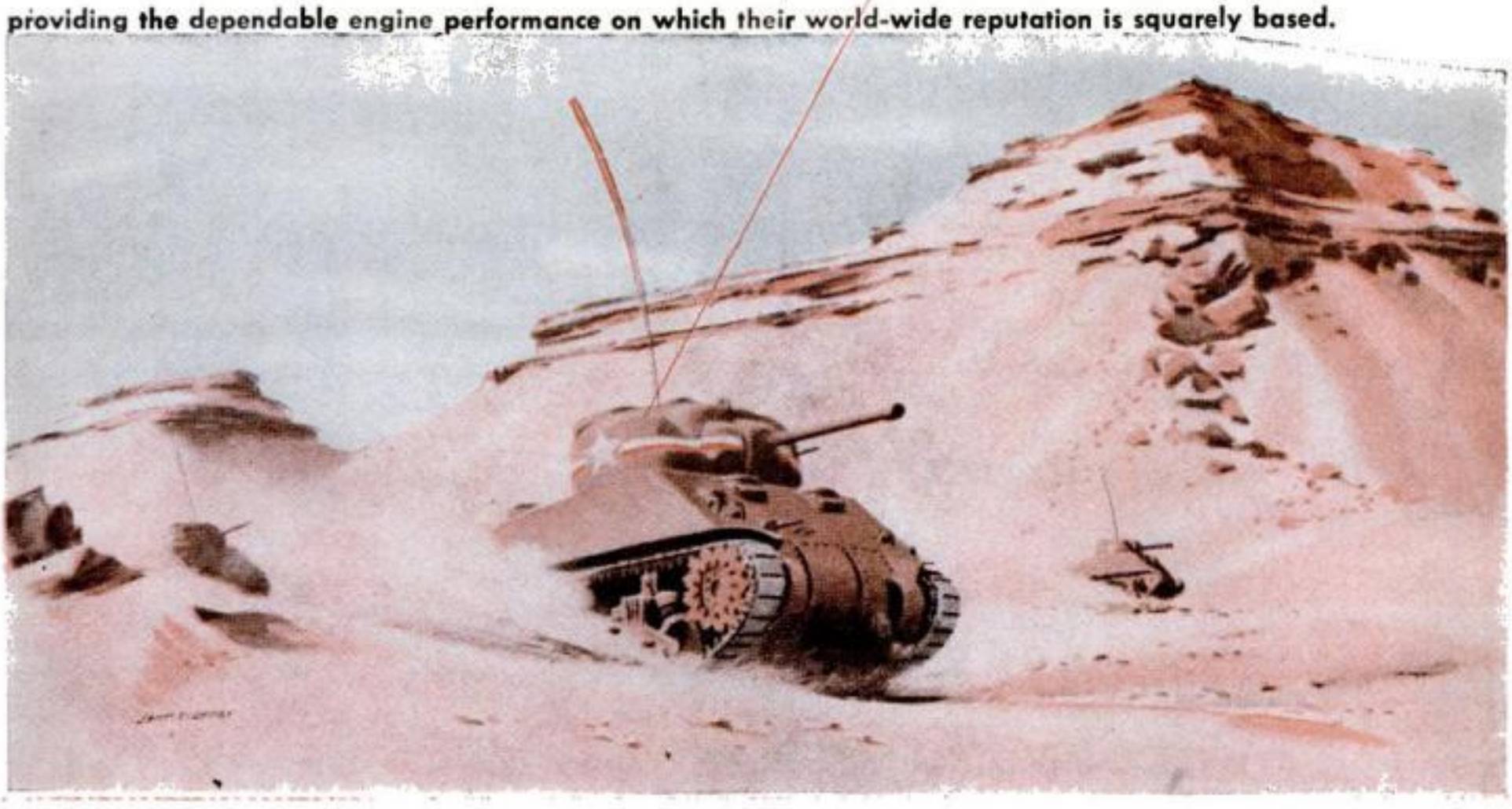

Armored and armed to the teeth, asking and giving no quarter and operating almost regardless of terrain, the effectiveness of our giant tanks depends on their mobility. Giant engines must not fail, and for that reason the tank corps is very conscious of the importance of spark plugs, and the necessity of regular inspection to keep them in top-notch condition. Champion Spark Plugs have earned an outstanding reputation for dependability here, as with other branches of our fighting forces. This enhances Champion's long standing reputation for better performance—and emphasizes the reason for their world-wide preference by motorists. . . . Check your spark plugs—have them tested, cleaned and gaps re-set at regular intervals, to insure maximum economy and dependability. When you need new spark plugs insist on Champions.

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Coming Next Month

OUR AIRCRAFT ENGINES, like everything else connected with military aviation, have come in for a lot of discussion in recent months. What are the facts about the power plants that are the hearts of our fighting planes? What do they do, and how do they compare with those of our enemies and our allies? You'll find the answers in a timely article.

OUT OF THE MELTING POT metallurgical magic has brought countless new alloys to add strength and effectiveness to our war weapons. By blending metals in strange combinations, they produce hybrid materials with just the qualities they want for the job in hand. Read the secrets of this modern alchemy and what it is doing to help win the war.

RAISING RABBITS FOR MEAT will help many families eke out their rationed supply. A breeding stock of four does and a buck will provide one or more hearty meals a week, with little space or trouble. Andrew R. Boone tells you all you need to know to get started toward tasty and nourishing dishes of fried rabbit, fricassee, and stew.

WHAT'S IT LIKE inside a German submarine? You have heard a lot about the depredations of these undersea wolves, but have you ever wondered about the secrets of construction and operation that give them their devastating power? P. S. M. takes you inside a captured U-boat and shows you what makes it tick. Pictures show how the crew lives in its cramped quarters during the long voyages to and from the convoy lanes.

DO YOU KNOW HOW TO READ? Reading is hard work—the most difficult visual task that human beings perform. If you do it the right way, you will save your eyes a lot of wear and tear in a job for which nature never intended them. Science gives you a reading lesson that will pay you dividends in better vision and less fatiguing eyestrain.

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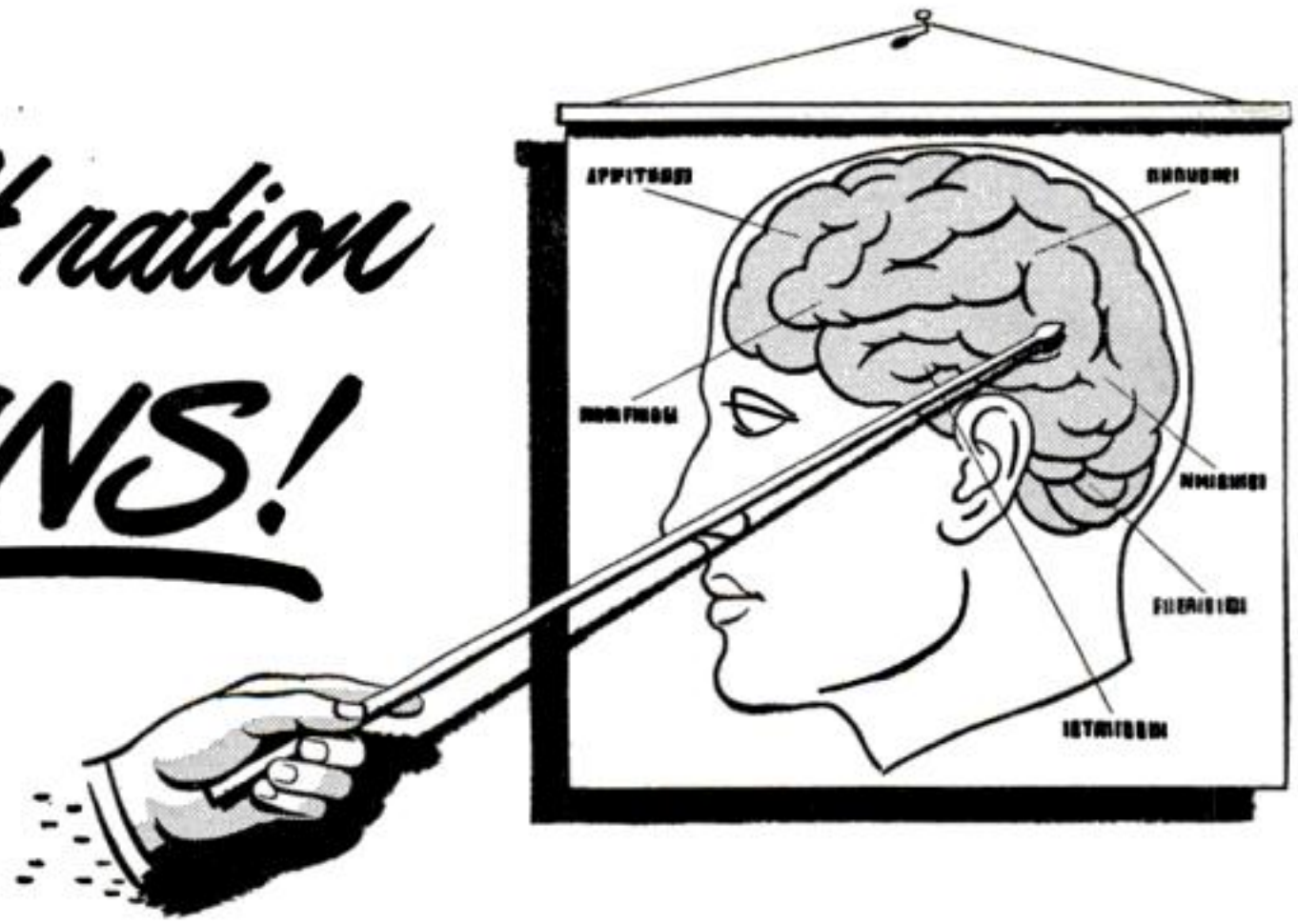

EVEN the brutalitarian dictators can't ration *brains!*

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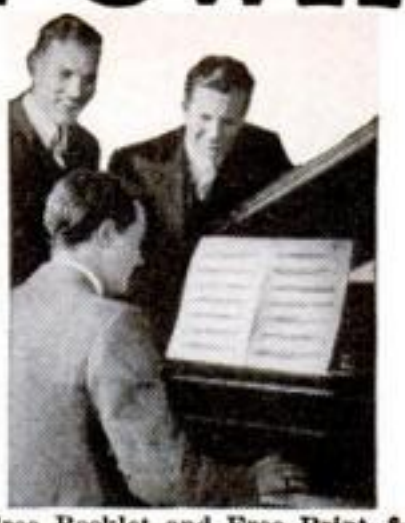

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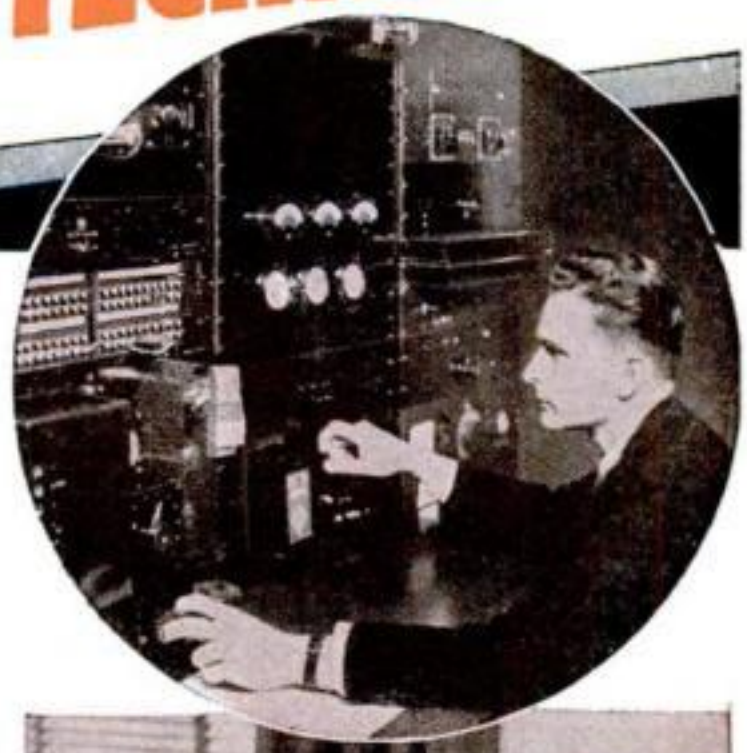

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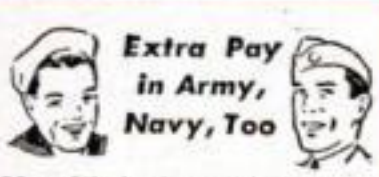
BROADCASTING STATIONS (top illustration) employ Radio Technicians as operators, installation, maintenance men and in other fascinating, steady, well-paying technical jobs. FIXING RADIO SETS (bottom illustration), a booming field today, pays many Radio Technicians $50 a week. Others hold their regular jobs and make $5 to $10 a week extra fixing Radios in spare time.



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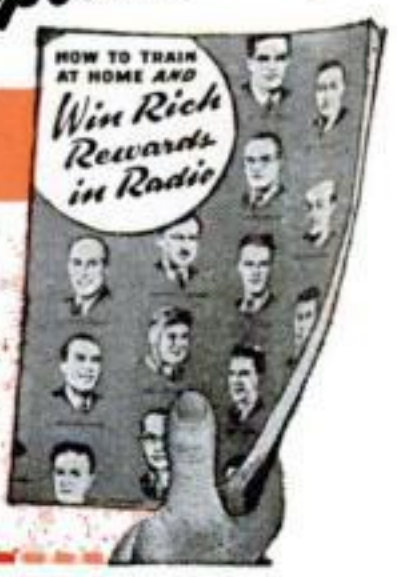

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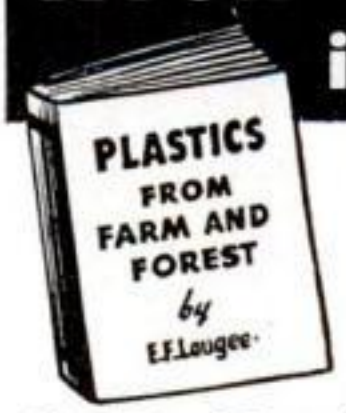

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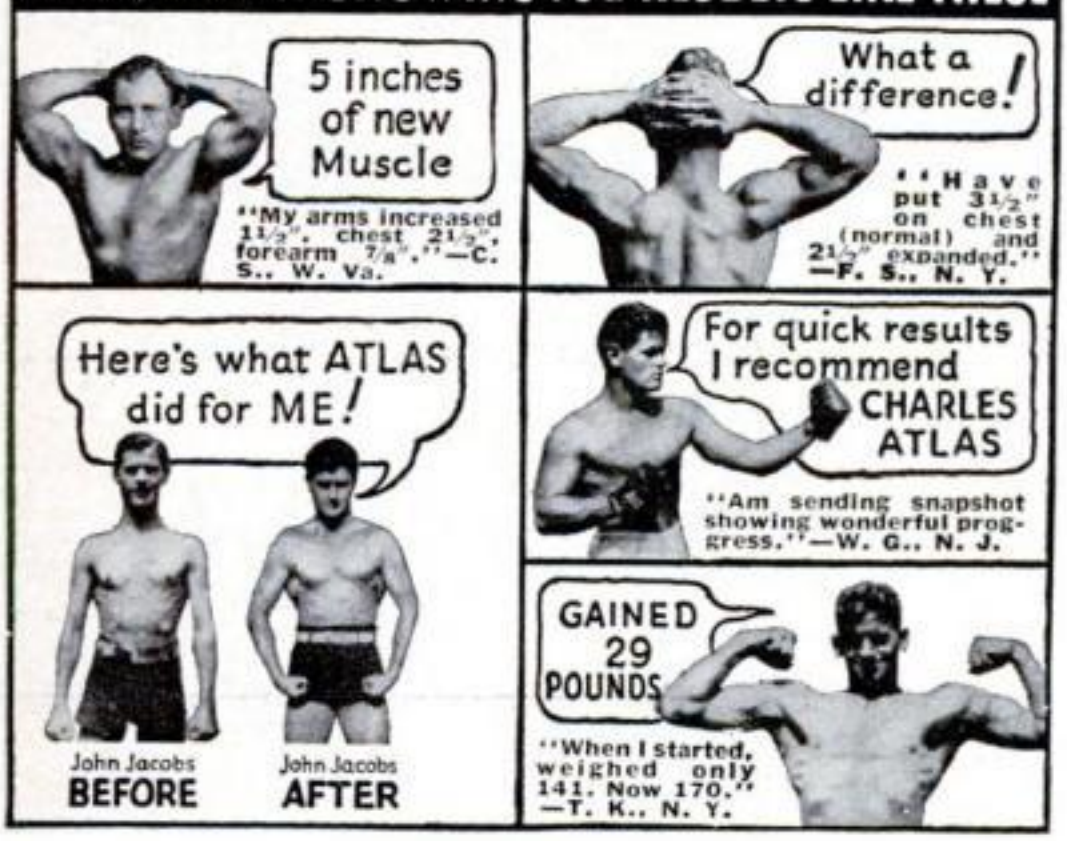

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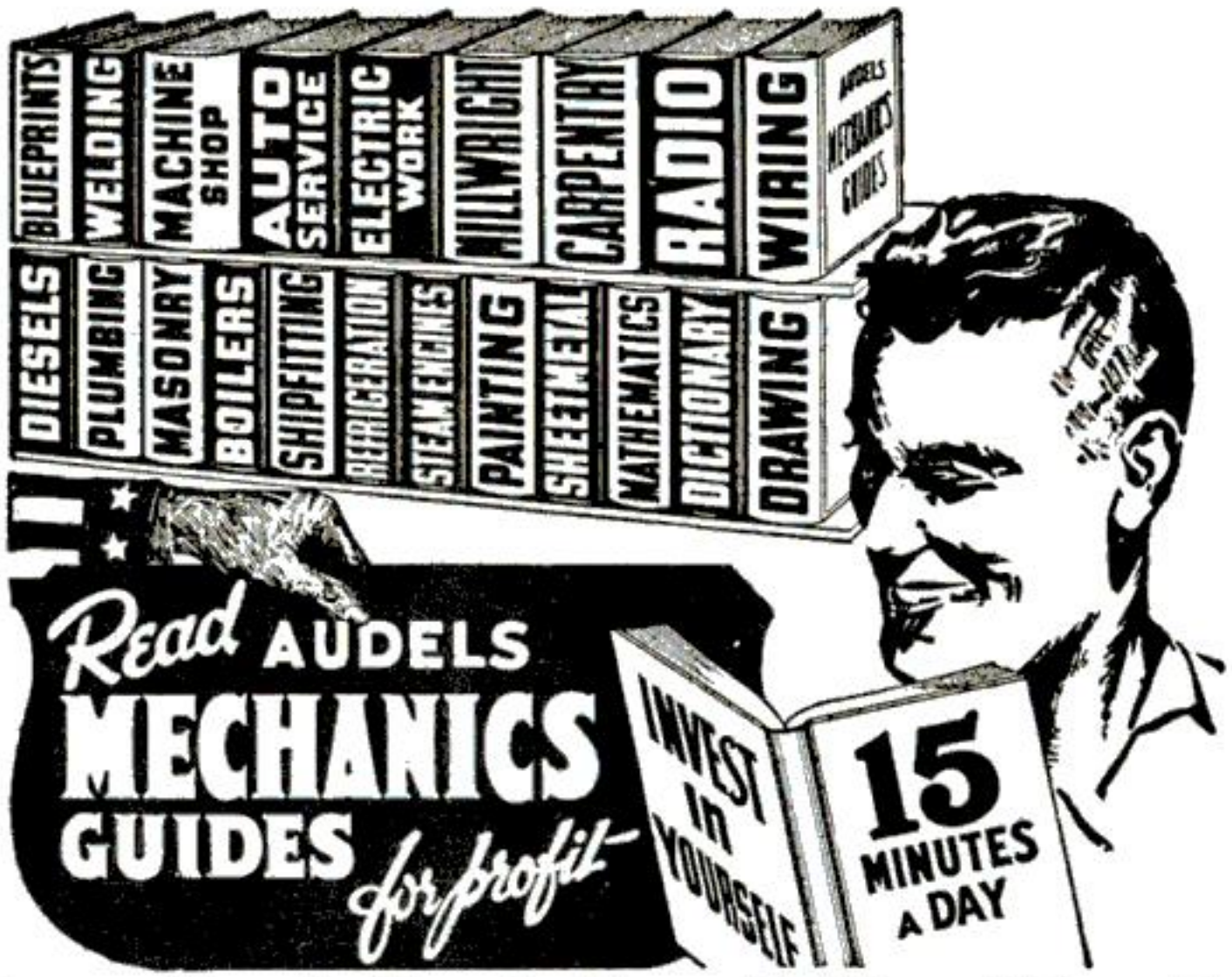

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Readers Say:

Hunting Down Our Dinner-Meat Rations with Arrows

I AM AN inventor and have just developed a new type of dinner plate which I wish the world at large to know of—specially editors, who are busy men. The plate is marked with a number of arrows all pointing toward the center of the plate so that a man sitting down to his dinner will have no trouble locating his dinner-meat ration. The invention will also assist his wife, who will know just where to place the meat so that her husband won't waste valuable time hunting it down. I think my invention will go a long way toward improving family life in these trying times. I am also working on a similar indicator method for beans, and I think I'll succeed if only I use enough arrows.—W. D., Tulare, Calif.

What Started the Chicago Fire Is Still a Burnirg Question

I WOULD like to raise the question of what was the cause of the Chicago fire and all the other fires that occurred simultaneously in that city on the night of October 8, 1871. According to the latest discoveries of comets and meteors, it is evident that it was a meteor of the less solid but more magnetically powerful type that caused the great conflagration. This is borne out by the many strange facts that lie hidden in the reports of the catastrophe. For instance, people were found dead without their clothing or hair burnt, yet with coins fused in their pockets. Piles of pig iron were found fused—despite the fact that the pig iron was comparatively distant from burning buildings or other sources of heat. Strange colored flames were seen to leap from the cornices of buildings, and houses suddenly burst into flame for apparently no reason at all. These strange occurrences should lead scientists to look farther than Mrs. O'Leary's cow as the cause of one of our greatest calamities.—C. W. D., Vancouver, B. C., Canada.

He Feels Someone Should Chew This Over

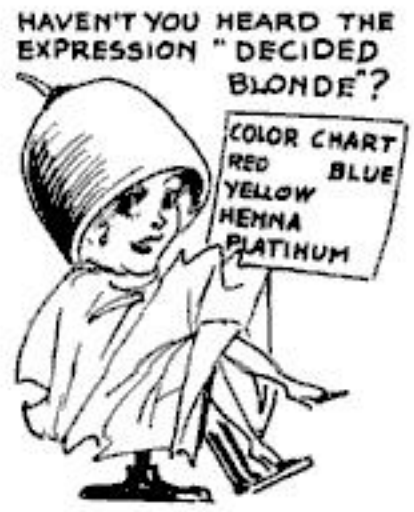
IT IS a well-known fact that very old people sometimes sprout a third set of teeth. The deduction, as I understand it, is that the nervous system goes a bit "haywire" as the end of life approaches, and that this nervousness revives the functioning of a gland, such as the thymus gland, which is active only in youth. If this is true, why wouldn't it be possible to inject some kind of thymus extract into the jaw, as a dentist injects novocaine, and so stimulate the growth of teeth whenever they are needed. Children and old folks grow new teeth regardless of whether their old teeth are in or out, which would indicate that the growth buds are not easily injured. It seems to me that this should be investigated.—M. C. G., Wayne, N. J.

Shift Your Sights, Men, and Let's Get That Rat

IN THE "With-The-Inventors" department of your April issue, you describe a poison gun to end the "depredations" of moles. It may interest you to know that for the most part moles live on an animal diet four-fifths of which consists of worms. The depredations you refer to are due to mice and rats who frequent the moles' tunnels and cause all the damage while the poor mole gets the blame. And the poison.—F. H., New Britain, Conn.

No Way for a Gentleman of the South To Talk, Suh!

I HAVE just received my March issue, and have noticed a picture showing Miss Jane Frazee with blonde hair. In your issue of June, 1941, is another picture of Miss Frazee—but her hair isn't blonde. I would like to know just what color hair she does have.—J. C., Knoxville, Tenn.



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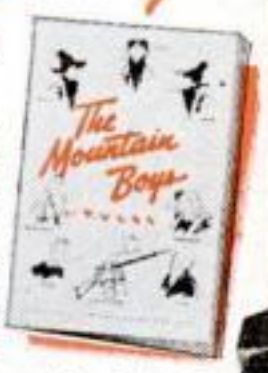

Readers Say:

P.S.M. Keeps Them Foot-loose and Fancy-free

I HAVE seen a number of men in the service reading your fine magazine, most of them with their shoes off, their feet elevated, and their eyes glued to the pages. Why their shoes off? To get the full measure of enjoyment from P.S.M. You see, doctors take care of their bodies, dentists take care of their teeth, and P.S.M., with its interesting and lively material, stimulates their minds. But there is one thing I want to know: who takes care of a soldier's feet?—M. C., Chicago, Ill.

A Fairy Tale for Those Who Cash Checks

AS AN ARDENT problem fan, I am sending you one that I think some of your readers might find interesting. I know that I did. Here's the problem: A man cashes a check for "X" dollars and "Y" cents at a bank. The bank teller makes a mistake in cashing the check and gives the man "Y" dollars and "X" cents. The man hurriedly picks up the money without counting it, rushes out to a store, and buys and pays for a $3.50 hat. On leaving the store it occurs to him to count his money. He finds that he now has twice the amount of money that the check was originally drawn for. The question: what was the amount of the check? It is to be assumed, of course, that he had no money in his pocket before he cashed the check.—R. S., Akron, Ohio.

Puzzle Prospectors Can Stake a Claim Here

HERE'S one that I think your problem fans will get as much fun out of as I did. How can 128 stakes be driven into a space 15 feet square so that no two stakes will be nearer to each other than 1½ feet. I'd be interested to see how many of your reader-experts can solve that one.—C. C. S., Vandalia, Mo.

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Readers Say:

Correction, Please—in the Interest of Stimulating Discussion

I WANT to commend you on your magazine, although there is one thing it lacks. There are not enough interesting discussions and exchanges of viewpoints between the subscribers in your "Readers Say" column. And one thing more. G. K. C. of Ganado, Arizona, whose letter appeared in your March issue, says the answer to the bouncing-ball problem which you recently published is 47.99996-9482421875 feet. He is wrong. The correct answer is 47.999969482421874 feet.—J. B., Malden, Mass.

That Dog Isn't Dizzy. He's Just Careful

I HAVE just received the March issue of your magazine, and have noted what A. M. T. has to say about dogs turning around several times before they lie down. He claims that a dog does that to "make his bed" and to pat it to suit his shape, just as a woman makes and pats a bed. I'd like to say I've learned that a dog does this purely from instinct—an instinct that goes all the way back to prehistoric times. In those days a dog, before lying down, turned around several times to make sure that no enemies were near. Today the dog doesn't know why he is doing it, but he does it anyhow. Doubtless he gets dizzy. —W. B. R., Atlanta, Texas.

A Two-faced Angle on a Regular Dodecahedron

I HAVE noticed that mathematical problems are often published in your "Readers Say" column. I have one to offer. Here it is: How many degrees are there in a dihedral angle formed by two faces of a regular dodecahedron? I've wanted that information for some time, but could not find it in any book. So I figured it out for myself. I found it an interesting problem.—M. J. L., Springdale, Ark.

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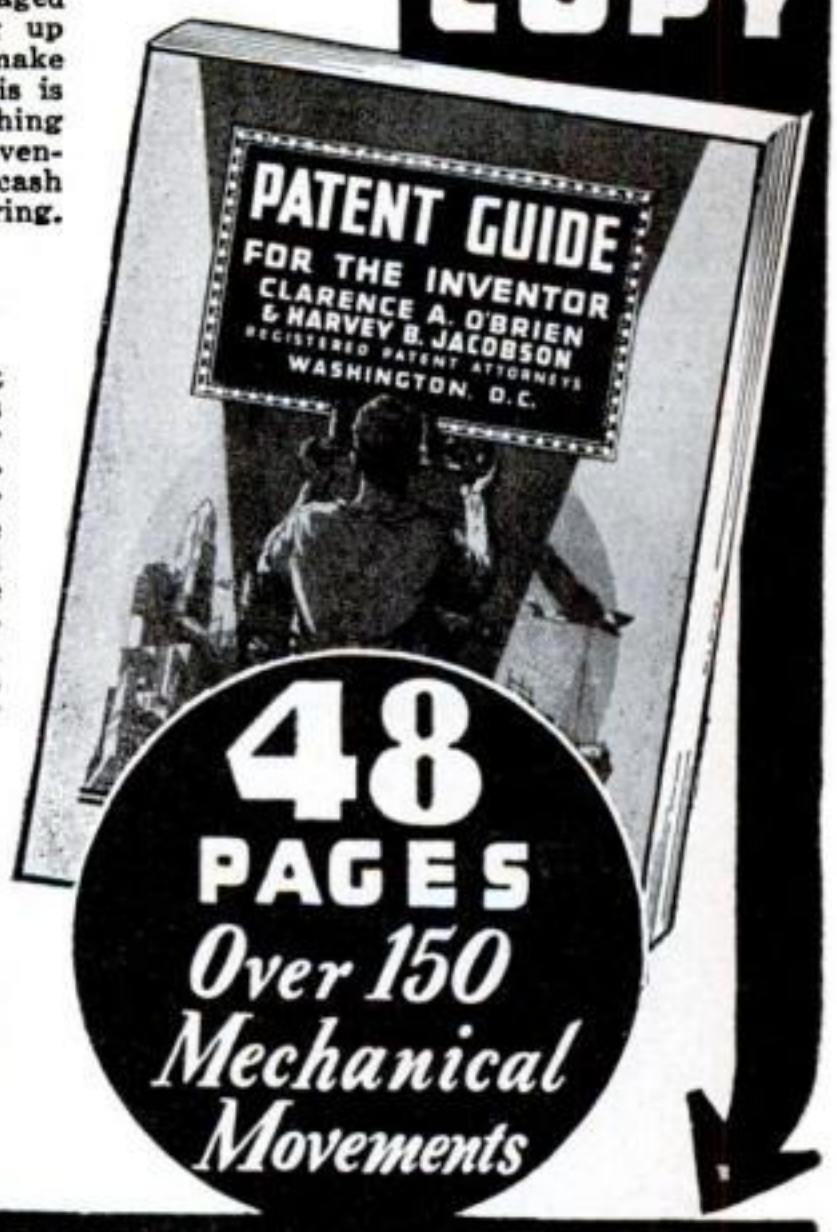

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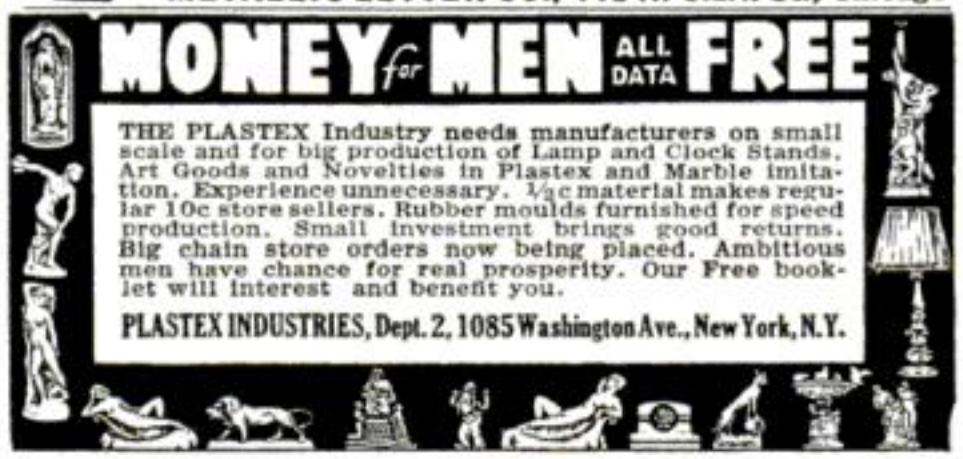

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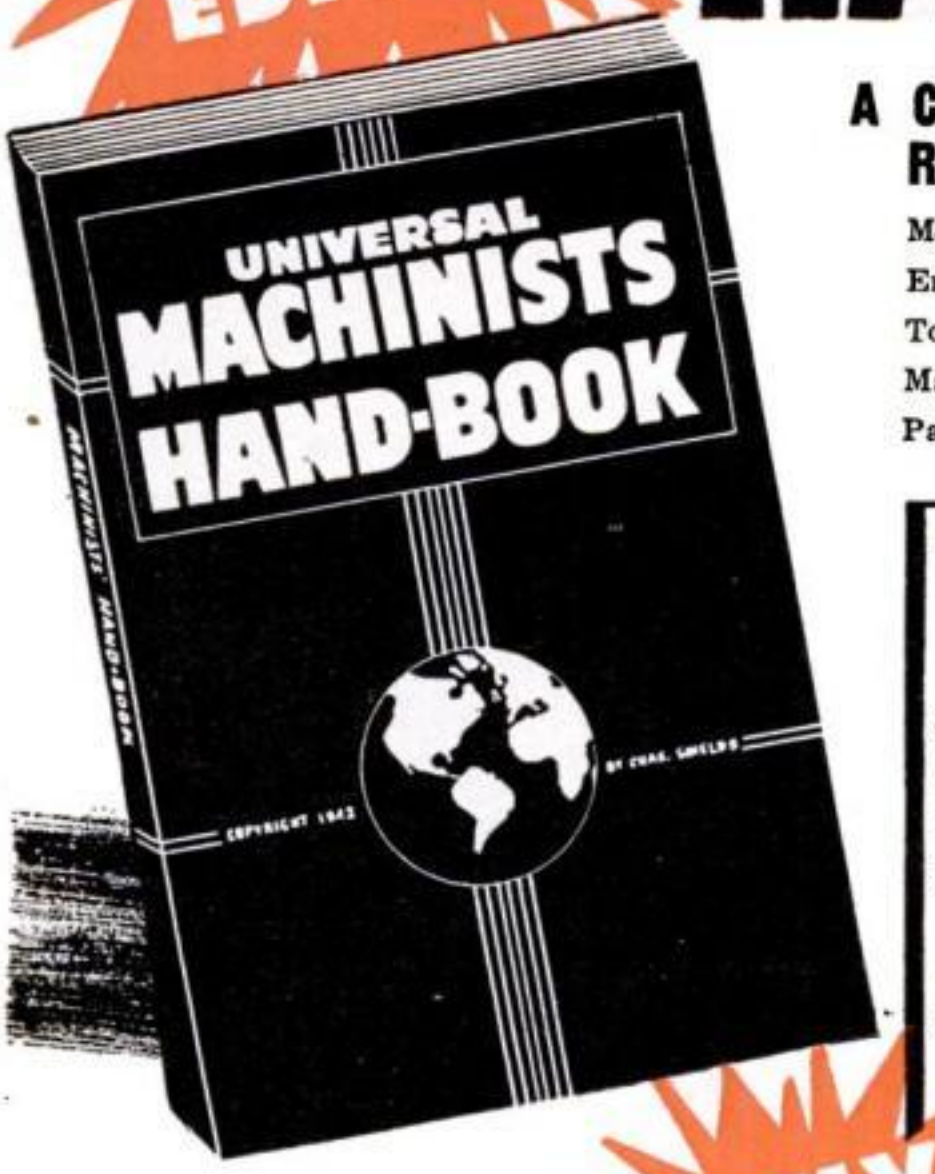

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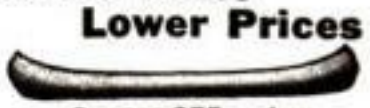

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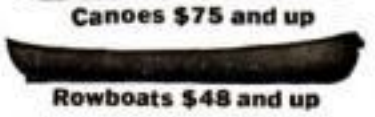

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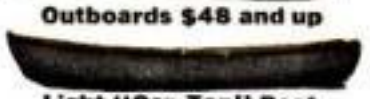

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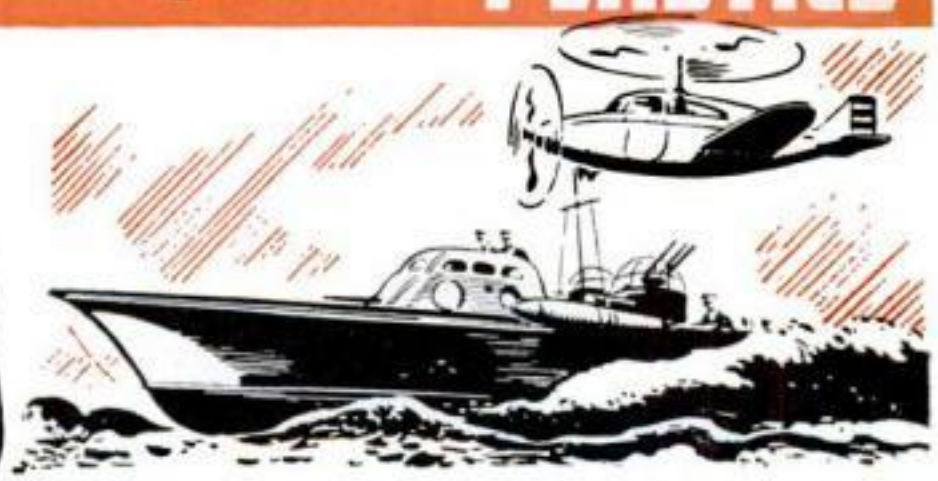

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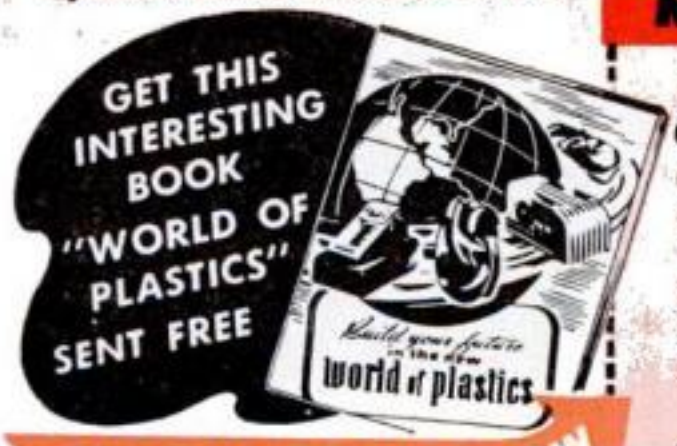

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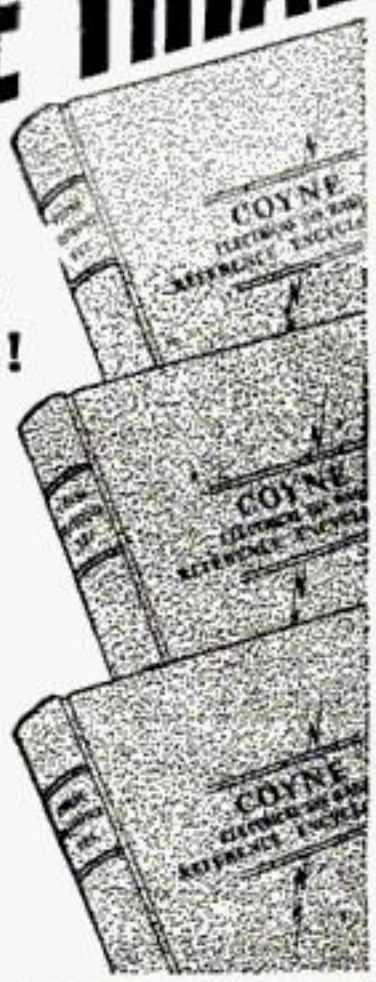

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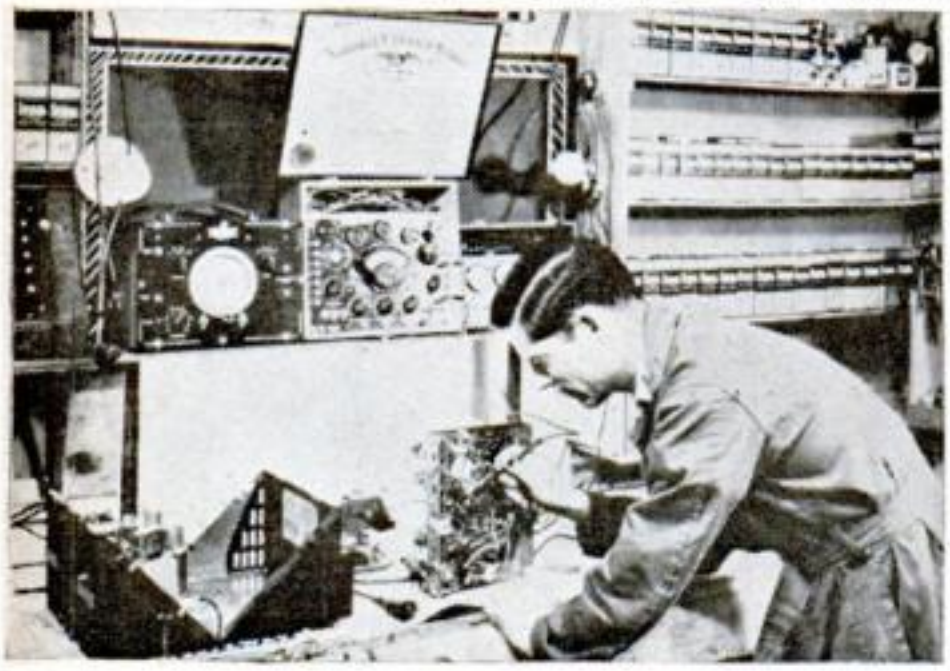

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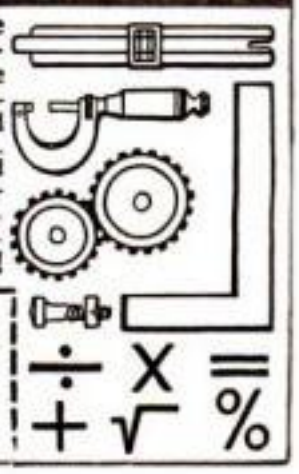

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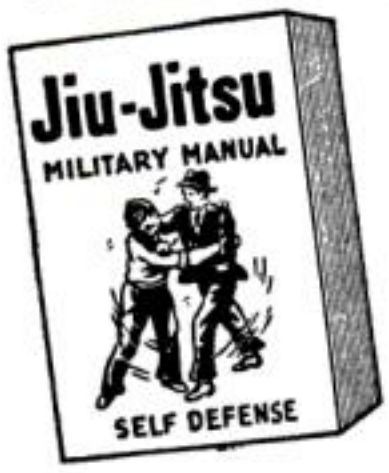

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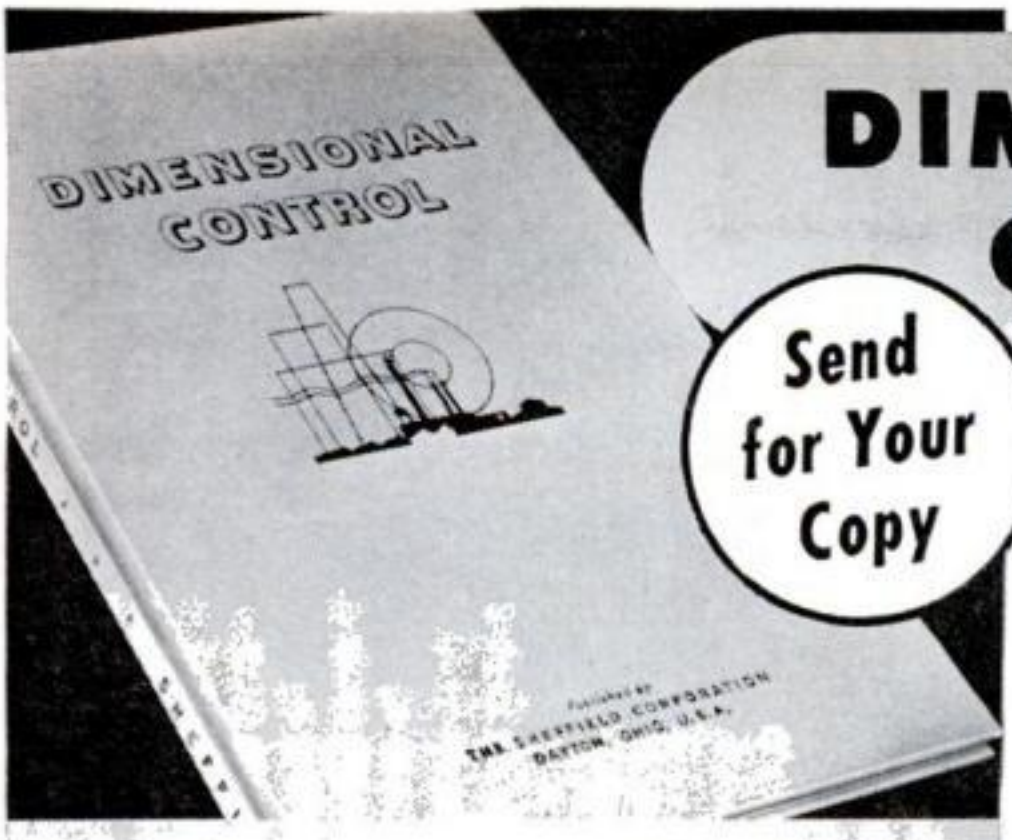

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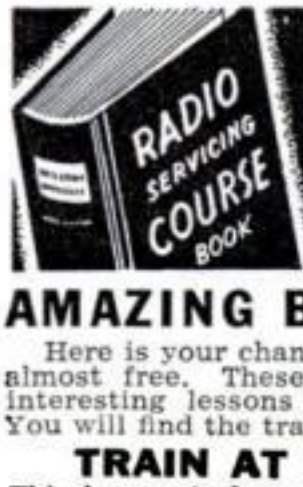

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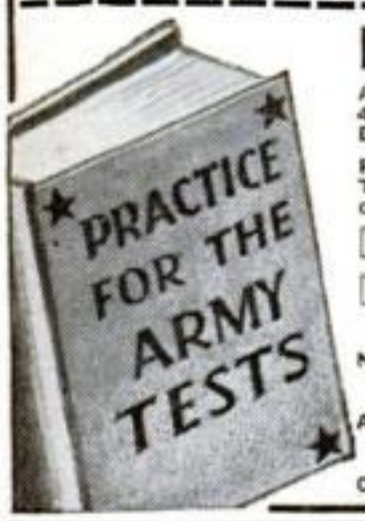

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Troopers on Wheels

In the scout car that forms the nucleus of a cavalry reconnaissance section, the lieutenant studies his map while the unit cautiously gropes for the enemy

A MODERN CAVALRYMAN IS A ROUGH-RIDING, HARD-HITTING MEMBER OF A TINY TASK FORCE THAT DOES A BIG JOB

By JOHN H. WALKER

Photographs by WILLIAM W. MORRIS

WHEN America's new Army swung into action against the Nazi foe in North Africa, and on every important fighting ground since, our battling divisions went into combat behind a fast-moving screen of highly trained mechanized cavalry—scouting the enemy, probing delicately for his strengths and weaknesses, pouring back a flood of vital information that enabled our commanders to dispose their troops to the best advantage.

This reconnaissance screen performs one of the most important services in war. The men who handle these missions are among the toughest, bravest, and smartest troops we can boast, and they are carrying on a proud tradition of American arms.

For today's U. S. cavalryman wears the crossed-sabers emblem on his uniform as proudly as any swashbuckling trooper of the glamorous past, although the weapon he yanks out of his leather scabbard is more likely to be a Tommy gun than a saber, and the scabbard itself is slung on a burly motorcycle or a go-anywhere jeep.

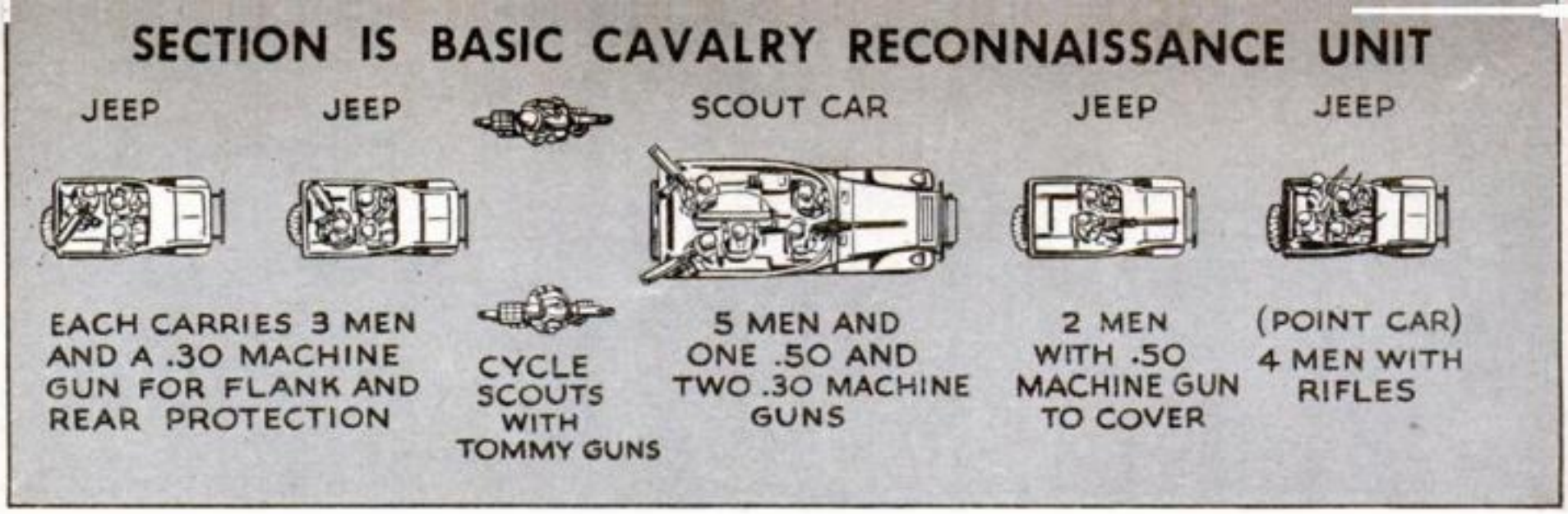
True, our Army still has crack horse outfits for specialized work, but cavalry in modern war is mainly mechanized, and its basic function is reconnaissance rather than combat—even though the nature of their work requires cavalry detachments to be among the fightingest units in any army.

The cavalryman in battle lives a life that can only be described as full and active. He operates as part of a miniature task force, usually well in advance of the main body of troops or far out on the flanks, often as much as 50, 80, or 100 miles behind the enemy's forward positions.

His is a slashing action—quick penetration of border or road guards, a headlong dash down side roads or trails, a blasting exchange of fire with an enemy strong point or counter-reconnaissance patrol. Then in a moment he becomes a stealthy intruder, horsing his vehicles up into the brush or woodland, hiding them under trees, putting out cat-footing patrols to probe for hostile encampments in the dark.

Always the cavalryman concentrates on getting the information, protecting it, and getting it back to the command post. In fulfilling his duties he must be tough as a commando and smart as a G-2 officer.

Mechanized cavalry units go into action



plentifully supplied with technical tools—vehicles, weapons, and radio equipment.

Their basic rolling stock includes the powerful armored scout car and the Army's new shaft-driven motorcycles, as well as the handy midget cars best known to the public as jeeps, although cavalrymen are more likely to call them "bantams" or "quarter-tons."

Reconnaissance details have their own "heavy artillery" in the form of hard-punching 37-mm. antitank guns and 81-mm. mortars. The cars also carry heavy and light machine guns, which, added to the rifles, carbines, and submachine guns of the men, add up to a very respectable fire power. Other weapons include ground mines, smoke and gas charges, and demolition kits with TNT charges, fuses, and detonating cord.

Radio communication naturally is the heart and soul of fast reconnaissance work. Cavalrymen working deep in enemy territory can feed a steady flow of reports to headquarters by means of the powerful Signal Corps code transmitters mounted in scout cars. For shorter distances, and particularly for advance reconnaissance when the heavier vehicles are in concealment and small observation parties go out in jeeps or on foot, the cavalry has a portable receiver-transmitter of special design, working with voice transmission.

The basic unit of organization for mechanized cavalry is the section, made up of a scout car, four jeeps, and two motorcycles. Two sections make a platoon, regarded as the main tactical unit in reconnaissance tactics, while three of these platoons make a troop.

A reconnaissance troop is assigned to each triangular infantry division, while each of our motorized divisions has a full "recon" squadron—three regular troops, an armored support troop, and a headquarters troop.

Headquarters troop handles such matters as supply, administration, communications, and motor maintenance. The support troop is designed as a heavyweight outfit, with 15 to 20 hard-hitting combat vehicles of the tank type, plus various supplementary cars.

A typical arrangement of a section operating on a road might find the scout car preceded by two jeeps and followed by the motorcyclists and the remaining two jeeps. The lead jeep, functioning as a point car, carries a driver and three riflemen, and is covered and protected by the second jeep, with two men and a .50 caliber machine gun.

The scout car, carrying the section commander, has light armor plate and packs a punch with a .50 and two .30 caliber machine guns. The cyclists normally stay close to the commander, ready to dart ahead or into a side road on short scouting missions, or to whirl around and head back to deliver messages or warn following units of danger.

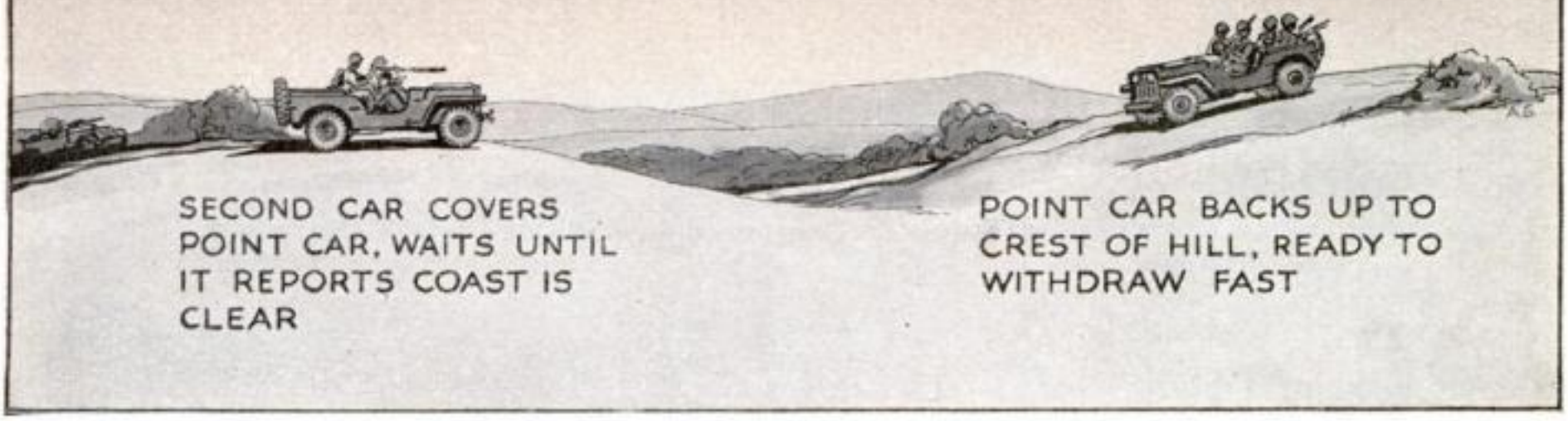
Each of the two jeeps at the rear carries three men and a .30 caliber machine gun. Their main mission is flank protection and reconnaissance. In an operation where enemy heavy units may be encountered—tanks, mobile assault guns, armored cars, and the like—one of the rear jeeps probably would be assigned to tow a 37-mm. antitank gun.

This road arrangement is capable of wide variation, of course. If the outfit hopes to smash through light enemy resistance at high speed and move on into open territory, the scout car may lead the way. This means running the risk of road mines or concealed artillery, yet in some circumstances the advantage to be gained might be worth the try.

Obviously, it takes cracking good soldiers to carry out these missions, with their wide range from head-on combat to stealthy scouting. Cavalrymen are good and they look it—tough and businesslike in the drab greenish-gray coveralls which serve as their battle dress. They are quiet and watchful, as befits troops who may be spending a good deal of their time in enemy territory. They are the kind of soldiers who carry their weapons along to mess, and disperse under the trees to eat without being reminded of it.

The teamwork required in a scout car and the supporting elements of a section rivals that of a heavy bomber crew. The commander, to begin with, must have expert knowledge of all his vehicles, weapons, and communications equipment, and of the enemy's as well. He must be expert at visual reconnaissance, have a sound understanding of intelligence problems to make his reports

"ADVANCE BY BOUNDS" GIVES A STEALTHY APPROACH



THE SCOUT CAR SERVES AS A COMPLETE MOBILE G-2 UNIT

Two heavy .30 caliber water-cooled machine guns guard the flanks and rear. Other armament of the scout car includes a .50 machine gun in front, on a tripod so that it can be removed for use on the ground, and the small arms carried by the five men

Getting information is the chief mission of the reconnaissance section, and radio communication is its heart and soul. Here the commander gets a message received on the powerful code set. Observation parties use a portable set of special design

When things get hot, the windshield is "buttoned up" with its armor screen. Here the lieutenant is peering through the slit, holding his Tommy gun ready for action. The scout car is rallying point for the section and clearing house for information

Many operators wear their earphones outside the helmet, as at right, using the pot as an amplifier. Navy helmets, which allow earphones to go inside, will be issued to the cavalry. Below, a spring clip holds key on the knee

This jeep packs a wallop with its tripod-mounted .50 caliber machine gun. Note the windshield cover that prevents fatal light reflection from the glass. If radio communication is uncertain, a message may be dispatched by one of the motorcyclists, as at right

to headquarters of maximum value, and know methods of supply and techniques of construction well enough to do a swift and efficient job of demolition if the chance arises during a sweep through hostile territory.

In addition, the cavalry leader must have a good grip on basic infantry combat tactics, as well as the specialized tactics of his own branch. And he must have a thorough knowledge of maps, navigation, and orientation problems. This latter qualification came to the fore especially throughout the desert fighting in North Africa, where many sweeps of hundreds of miles were carried out over the trackless sands, depending entirely on compass readings, dead reckoning, and celestial observations.

The more of these skills a trooper acquires, the better all-around cavalryman he becomes, although naturally his primary concern must be his own specialties in the team setup. Thus the driver's first concern must be his combat vehicle. He has to be able to handle it across any going from a concrete highway to a shallow creek and perform the elementary repairs and maintenance the Army classes as "first echelon."

Aside from that, he must know the ways of camouflage and concealment. He must have a hair-trigger reaction to signals and commands, and must blend with the other vehicles on the road as a good taxi driver blends with fast-moving traffic, anticipating what the other drivers are going to do.

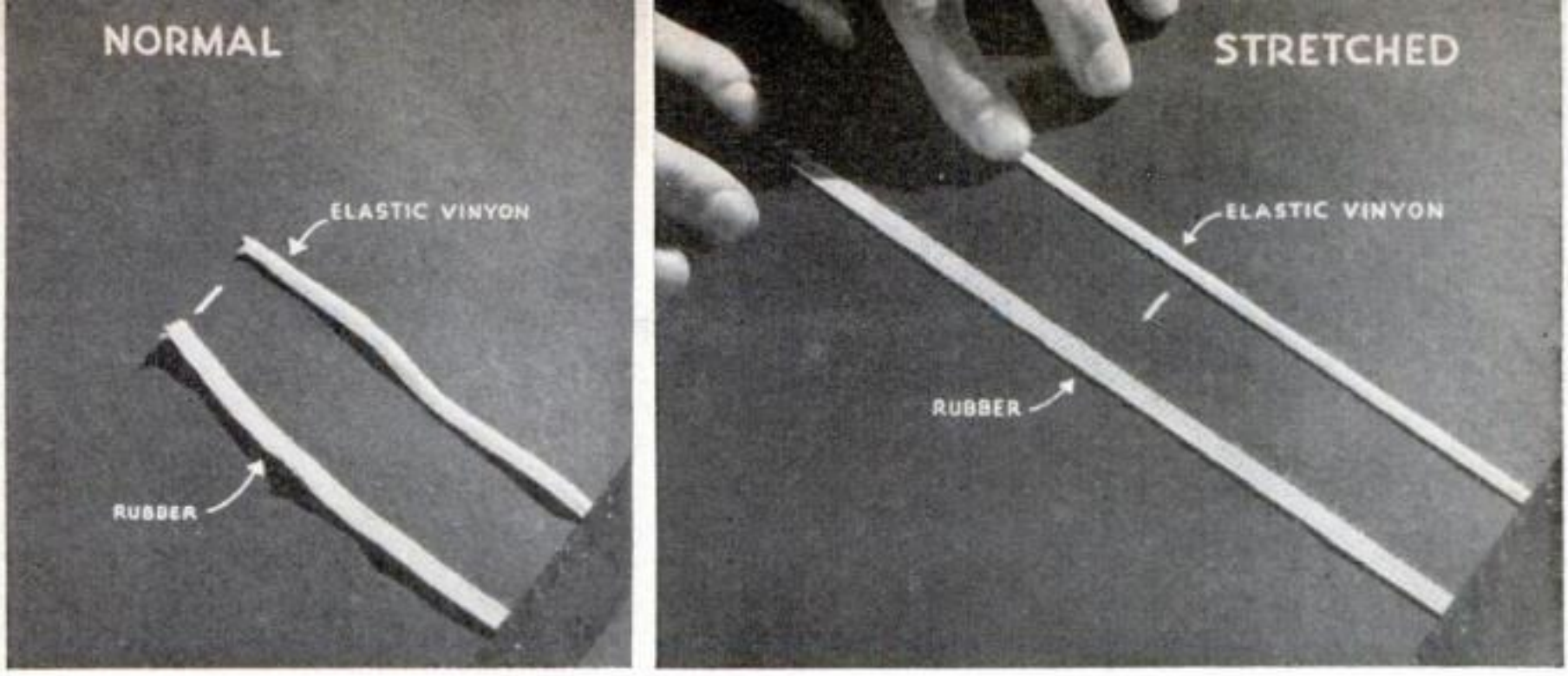
The cavalrymen who ride the bucking jeep must be ready to function as the point of the column, and keep a wary eye on the road for buried mines—one of the mechanized troopers' worst hazards. They must know how to read maps and keep themselves oriented at all times, and must have special preparation for effective reconnaissance, including the ability to judge numbers of men and vehicles on a road, the approximate size of enemy camps, and the difference between the enemy's special types of heavy and light artillery, or heavy and medium tanks. They must also be expert riflemen and machine gunners, able to lay down an effective harassing or covering fire.

Motorcycle scouts are as tough and handy as any men in our Army. It is scarcely possible to overestimate the courage and physical stamina it takes to chauffeur one of these over-powered, war-going kiddie cars down pounding hard roads, over washboard or corduroy surface, dodging boulders, and slithering through sandpits, while the other men of the section enjoy the comparative luxury of squatting on a steel storage well and clinging to the relatively stable business end of a .30 caliber machine gun.

The cyclist is above all else a road agent —not in the old-time sense of the dashing outlaw who held up stage coaches, but in a new technique of swift investigation of side roads and suspicious terrain ahead. A motorcycle can do this job faster than any other vehicle. Often a jeep and 'cycle are paired for an assignment—the jeep to creep into suspected terrain and defend itself if necessary, the 'cycle always ready to rip back to the main body once the enemy has shown his strength.

Another special aptitude of the cyclist is the trick of running into trouble, doing a quick turn, skidding to a stop, and going into action at once with a Tommy gun or carbine across the protecting bulwark of his machine.

The radio man has an especially vital job, serving as the ears of the scouting detail. A good *(Continued on page 208)*

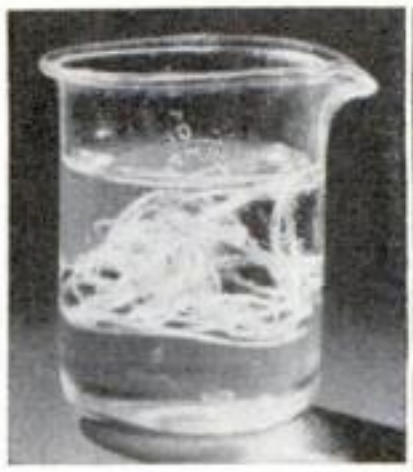


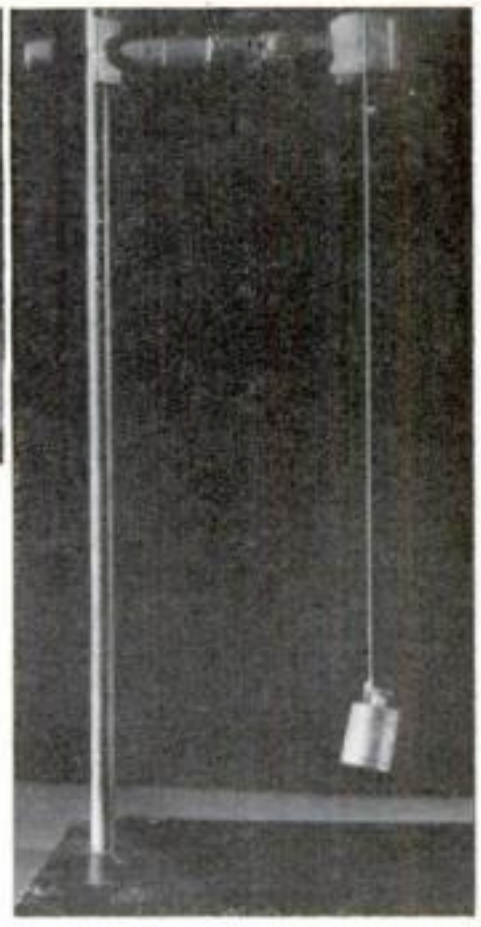
New Yarn Stretches Rubber Supply

AN ELASTIC yarn that is, however, not a synthetic rubber has been created from a vinyl-resin compound and is being substituted for rubber in military webbing, tapes, goggle straps, and undergarments for the "WAACS." It hasn't quite the stretch of real rubber, and its tensile strength is not up to heavy duty, but its resistance to weather, to body and mineral acids, and to many poison gases makes it superior to rubber for many light uses in war.

Tentatively called elastic vinyon, the yarn is produced from a plasticized vinylite compound which, in the form of a sirup, is extruded from minute holes to form slender filaments. After being dried and hardened, the filaments are laid side by side and joined together to form a thread that has the appearance and feel of ordinary textile material. Unlike rubber, the yarn does not have to be covered with cotton, rayon, or other textile.

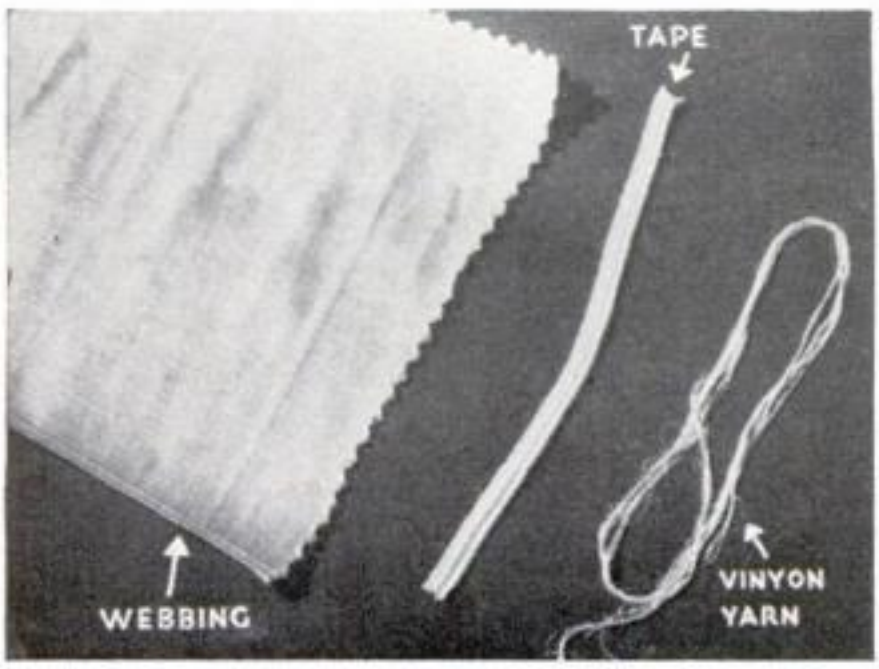
The elasticity of the new material may be altered by varying the composition, but the commonest type stretches to about one and a half times its original length. Rubber webs and tapes stretch from two to five times their original length. The new yarn is unaffected by boiling water, although it loses elasticity at freezing temperatures.



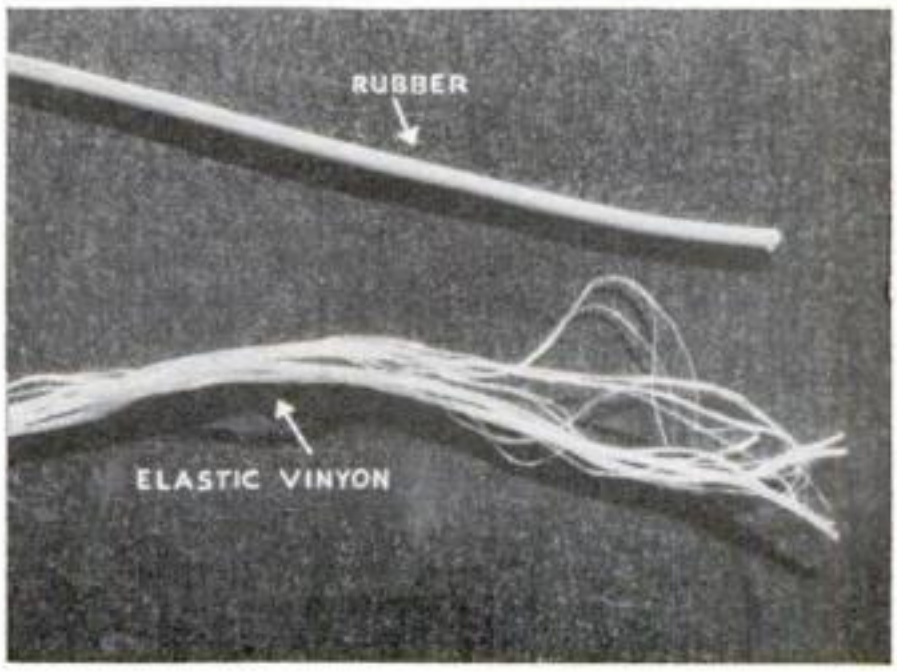


Neither humidity nor heat has any effect on elastic vinyon. A strand soaked in boiling water shows in the weight test at right that it has kept all of its "snap" and tensile strength. Only freezing temperatures will reduce its elasticity

Elasticity of the new yarn as compared with that of rubber is illustrated at top of the page. Below, the yarn, and tape and webbing made from it



The parallel filaments of elastic vinyon account for the pleasant feel of the material. A raveled strand is shown with a comparable rubber strand

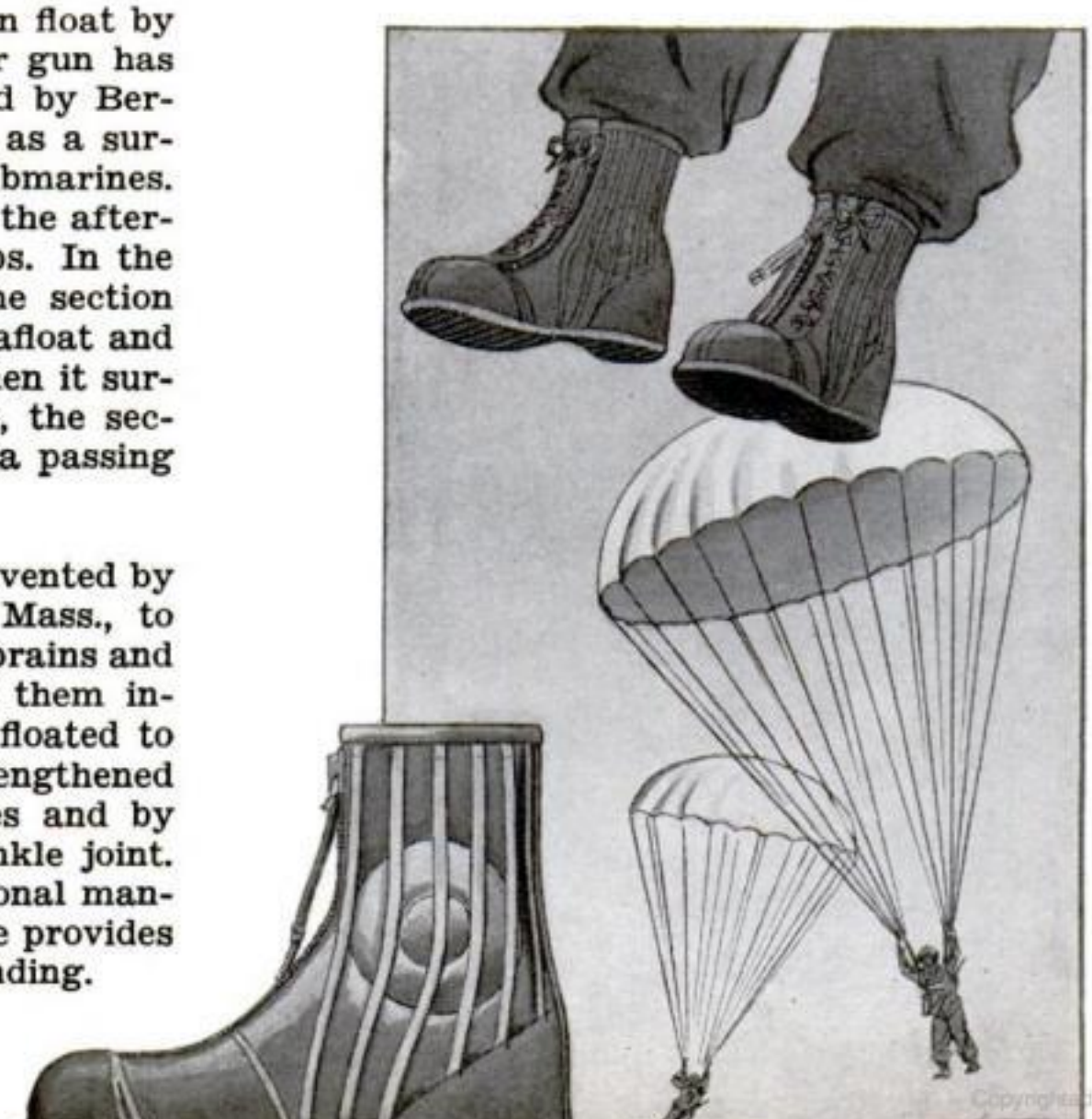


WAR

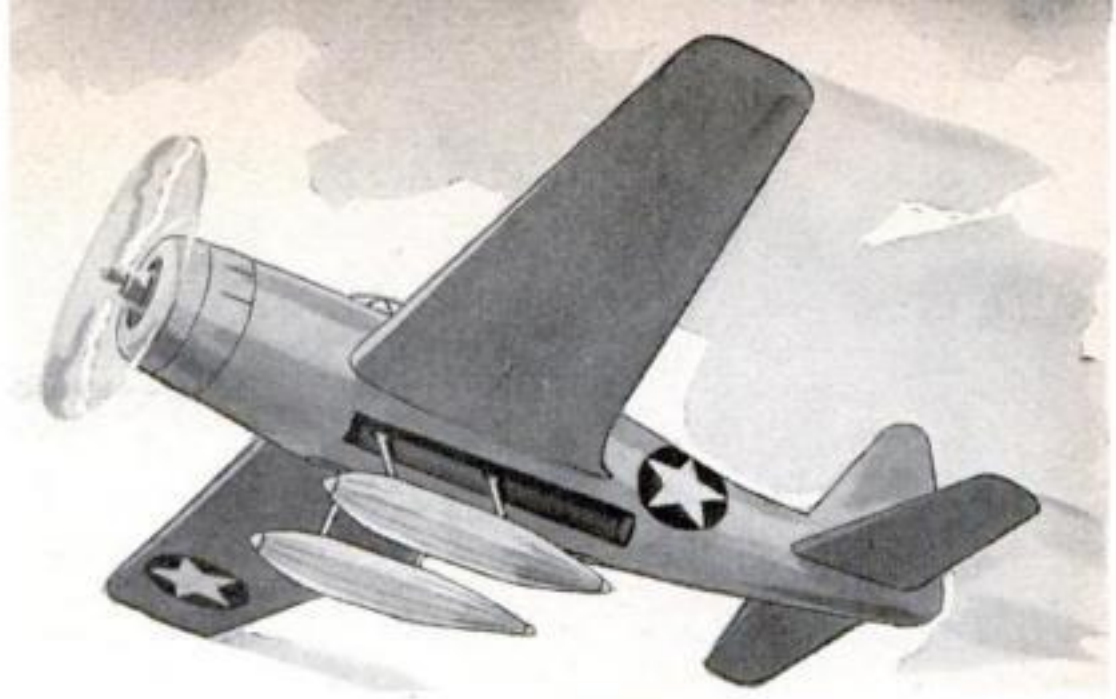
The proposed gun deck could be quickly detached from the sinking ship and set afloat to fire on the submarine when it surfaced

A DETACHABLE DECK SECTION that can float by itself and on which a high-caliber gun has been mounted, has been suggested by Bertrand Dickinson, of Yardley, Pa., as a surprise weapon in fighting enemy submarines. The deck section would be held to the afterdeck of a ship by means of clamps. In the event the ship was torpedoed, the section could be quickly released to stay afloat and to shell the unwary submarine when it surfaced. Equipped with food stores, the section could later be picked up by a passing friendly ship.

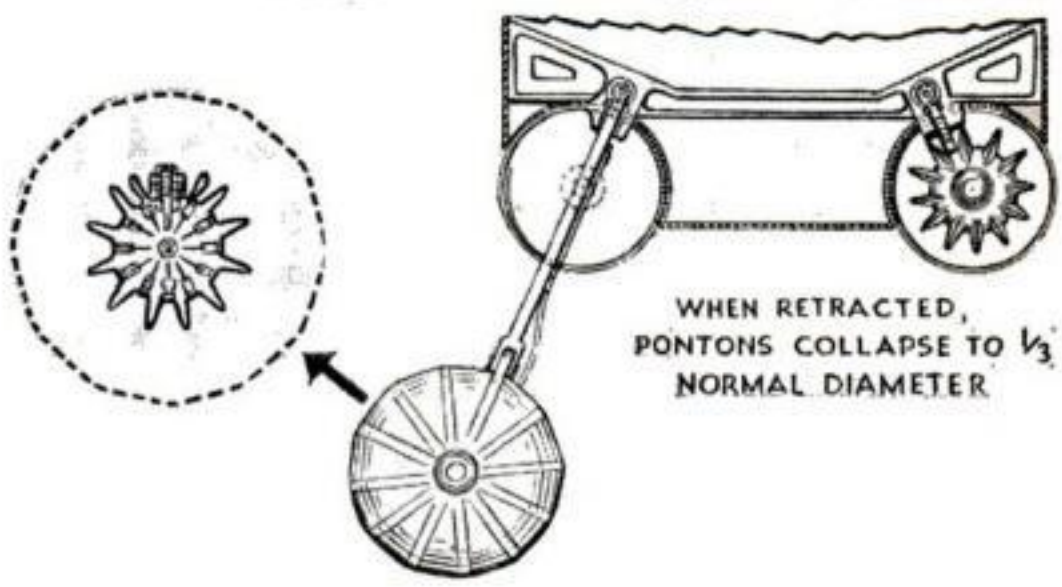
REINFORCED OVERSHOES have been invented by R. W. Jennings, of Cambridge, Mass., to protect paratroopers from ankle sprains and foot injuries which might render them incapable of action after they had floated to earth. These "parashoes" are strengthened by vertical fiber ribs at the sides and by a protective fiber disk over the ankle joint. They are laced up in the conventional manner, but a slide fastener at the side provides for quick removal on a "hot" landing.



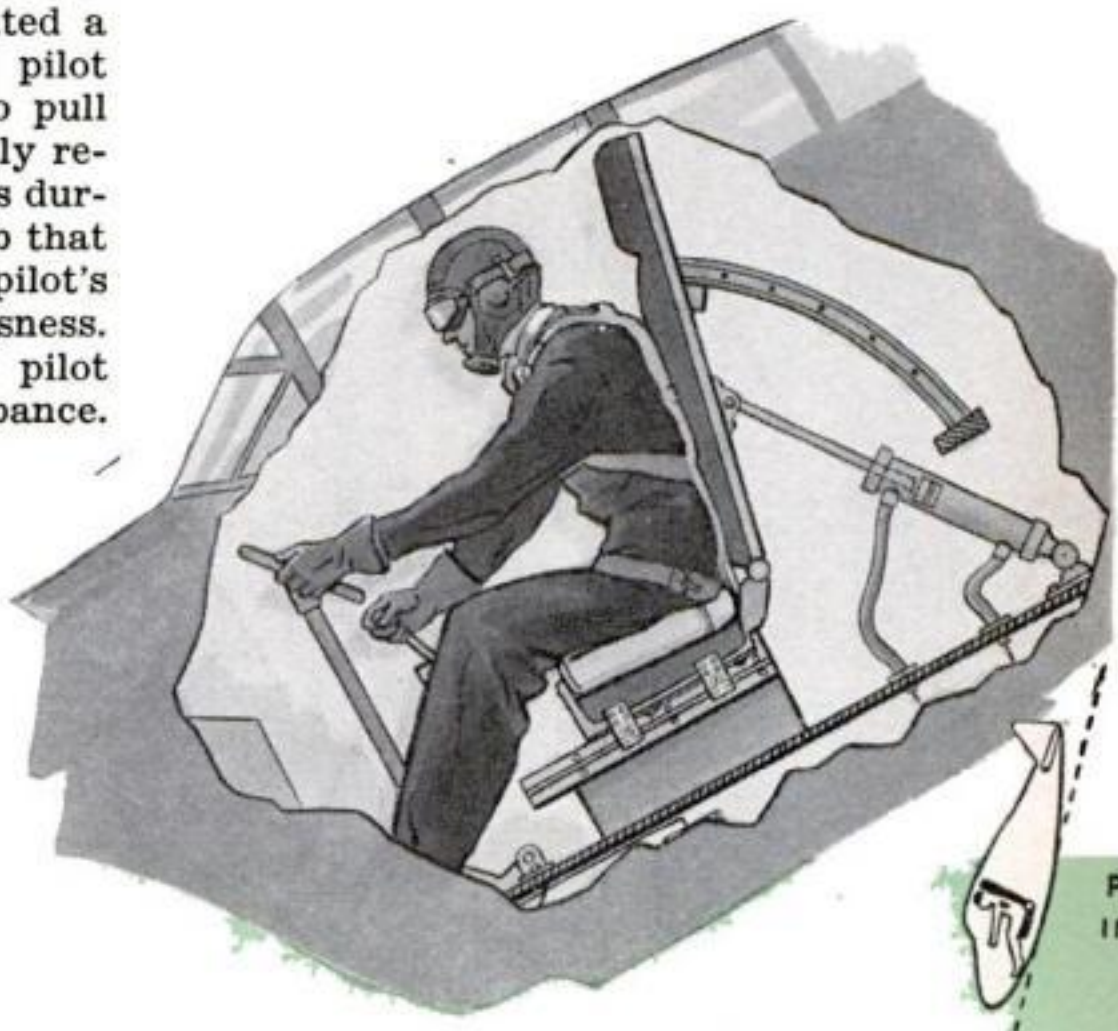
IDEAS

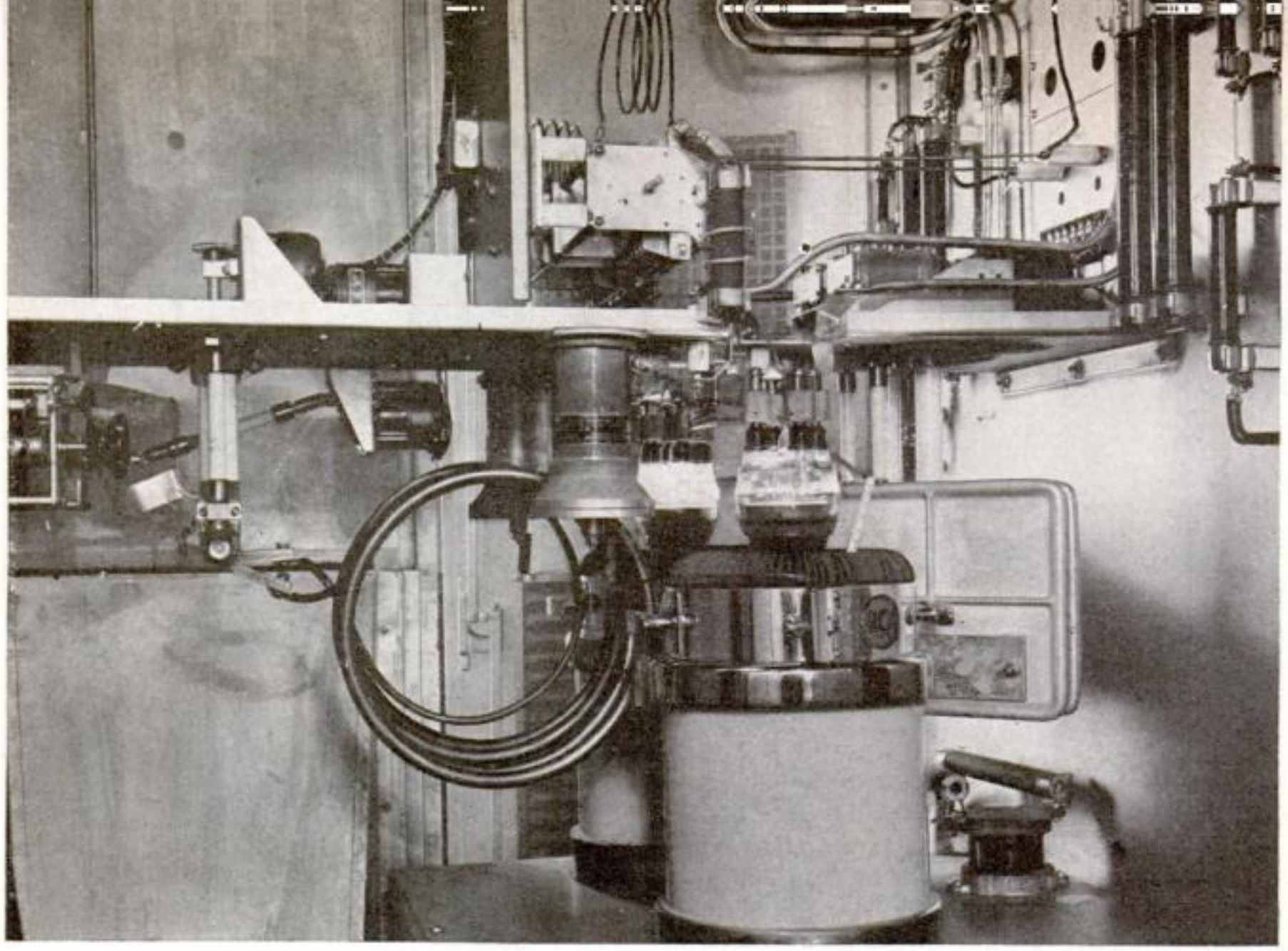


RETRACTABLE PONTONS have been patented by B. W. King, of Brooklyn, N. Y., to replace fixed pontons which impose a considerable reduction in speed and maneuverability on seaplanes. The invention provides for the pontons to be drawn up into the fuselage of the plane, but because pontons sufficiently large to support a seaplane would be too big to be easily retracted, the new floats are designed so that they can be collapsed to one third of their distended diameter. The diagram at the right shows the ponton as it appears when filled out, and, at far right, when retracted.



DIVE-BOMBER PILOTS are promised protection against "blackouts" by a Los Angeles inventor, F. P. Dillon, who has patented a seat that automatically lowers the pilot to a supine position as he begins to pull out of a steep dive, and then gradually returns him to an upright position. It is during the change from a dive to a climb that the blood is drawn away from a pilot's head, and he is liable to lose consciousness. By being in a supine position, the pilot avoids any such circulatory disturbance. Another feature which is incorporated in the invention is a mechanism that automatically takes over the flying of the ship at the instant the pilot releases his bomb, and continues to fly it until the pilot is well past all danger of blackout and can again assume control of the ship.





TRANSMITTER. Twin high-power vacuum tubes inside this transmitting unit are the source of radio frequency for a deep-heating process that molds laminated wood and resin into plasticlike substitutes for light metals. Waves from the tubes flow along copper ribbon to the treated wood

Working Wonders with DEEP HEAT

RADIOTHERMICS SPEEDS PROCESSES VITAL TO WAR EFFORT

By JACK O'BRINE

RADIO has produced a new marvel—a sprightly offspring that's doing big things for our war effort while still in its swaddling clothes. RCA engineers, who divulged its arrival, call it "radiothermics."

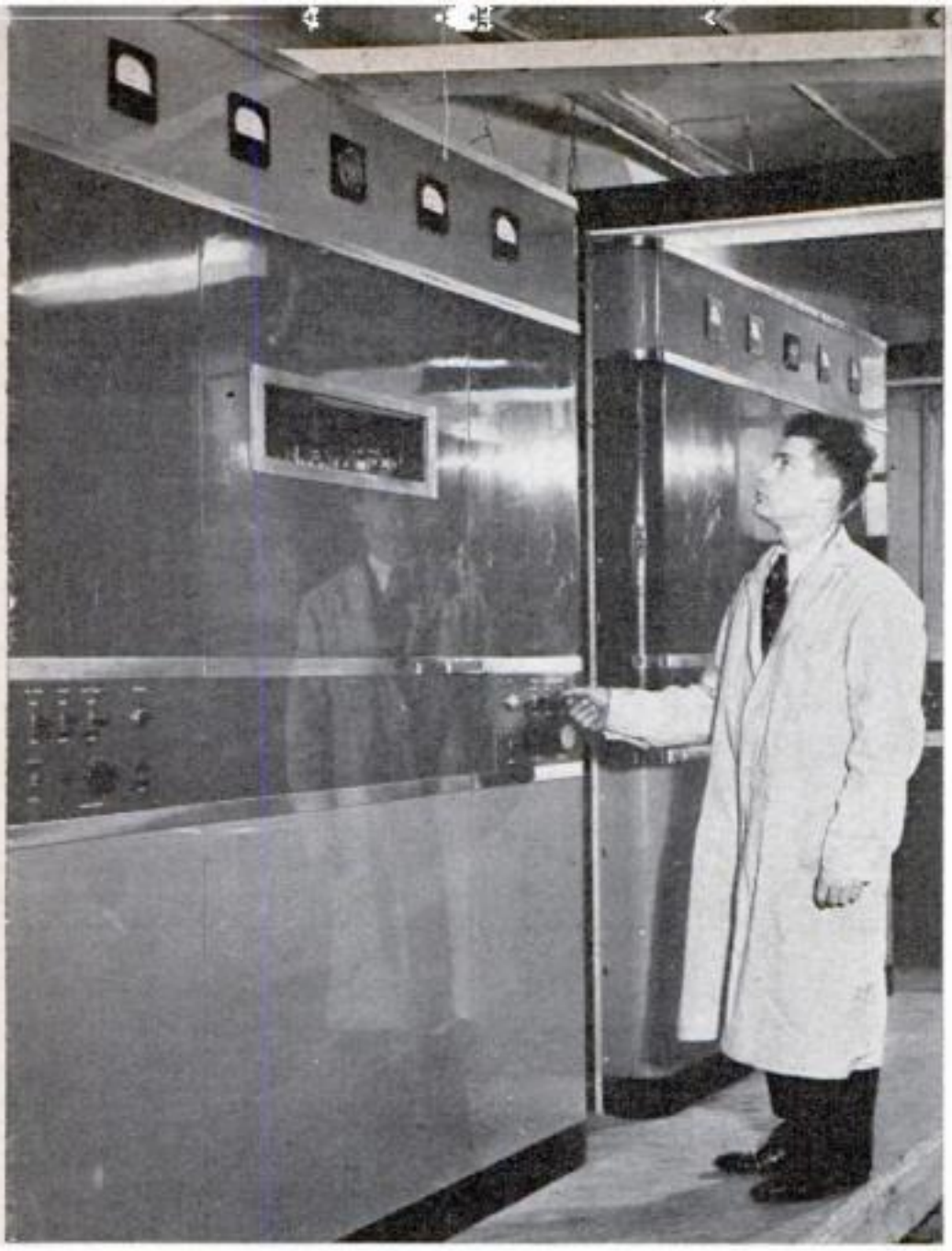
Resembling its brothers only in the wonders it conjures, radiothermics gives the "hot foot" to slow production methods. There is hardly an industry in which it cannot be used to speed output and to increase efficiency. Its accomplishments include heating, drying, stitching, gluing, case-hardening, welding, and riveting. It can do in minutes what once took hours.

We usually think of radio-frequency transmitters as a means of communication and entertainment. In radiothermics, the same high frequency provides uses that are revolutionary to industry. Before the end of this year, radio-frequency power for our war production is expected by RCA engineers to exceed the 3,712,000-watt total of all the broadcasting stations in this country. Looking further ahead, predictions for its uses are fantastic. Radiothermics is seen heating our homes, office buildings, and factories. It promises to revolutionize the baking industry. It may even cook our meals, light our lamps, and burn our refuse.

This new radio wonder has its seat in the high-power vacuum-tube equipment used in broadcasting. In fact, some broadcasting setups have been converted for its use. Most of us are familiar with the diathermy machines—artificial-fever generators—widely used by hospitals, clinics, and physicians. This radio-frequency machine creates heat deep within the body tissues. The same principle is used in radiothermics to generate heat for manufacturing purposes.

In the airplane industry we find an example. Radiothermics is proving ideal for the manufacture of propellers, test clubs, spars, ribs, and wing structures of laminated plywood. Using it to mold a combination of wood and plastics, the Duromold division of Fairchild Aviation Corporation has produced an experimental advanced-training plane for the Army—the AT-14, or Yankee Doodle.

Since radio frequency generates heat uniformly within the part, the time required to



CONTROL ROOM. Materials held under pressure in radiothermics can be brought to any degree of temperature by changing the output on this board

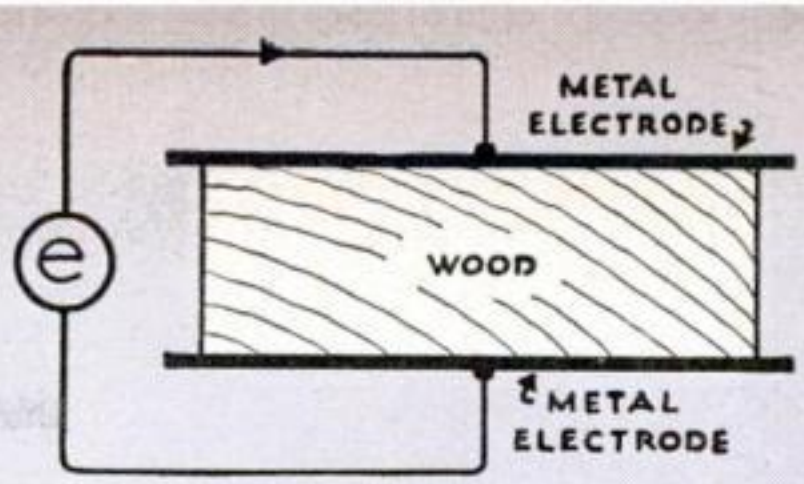


FIG. 1. This is the fundamental circuit for heating wood with radio-frequency power. Electrodes are connected to the generator (e)

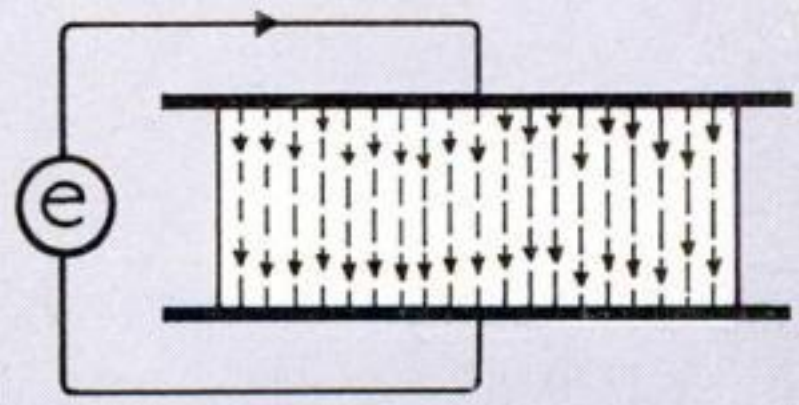
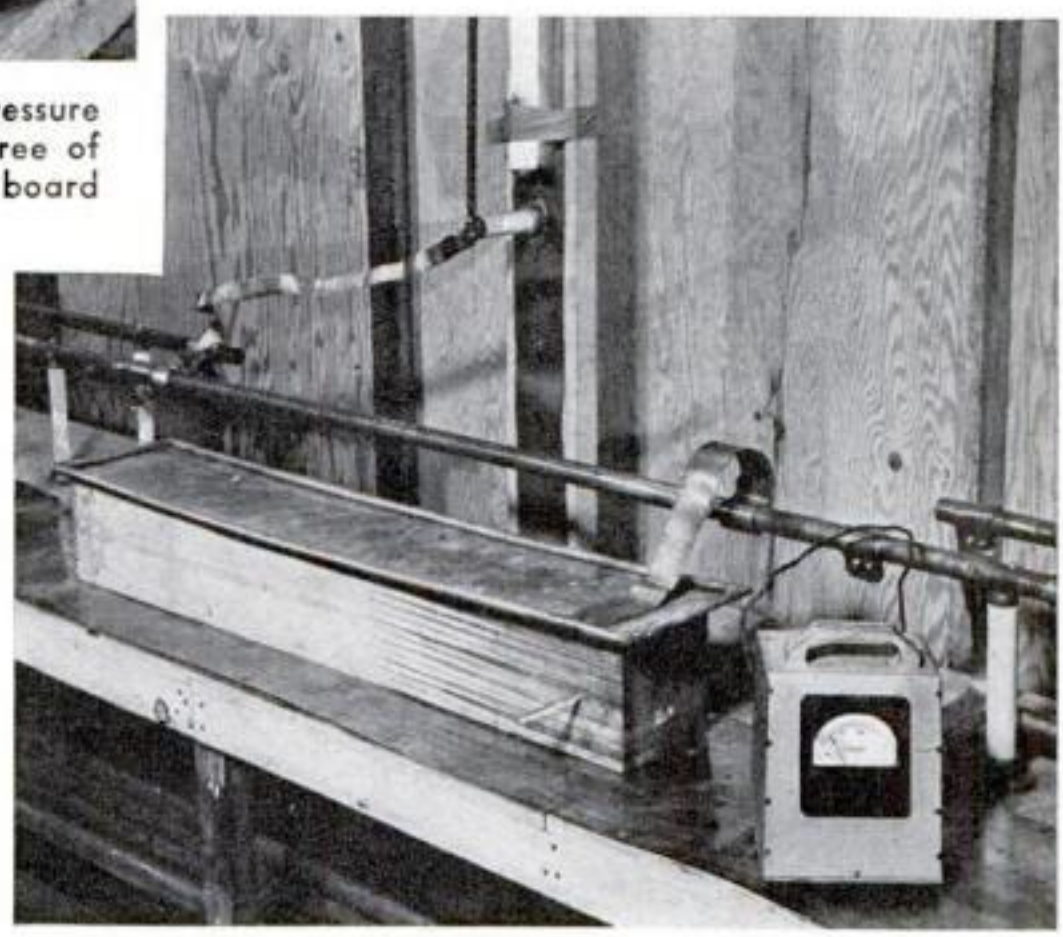


FIG. 2. Resistance to passage of radio waves causes the wood to heat. All sections reach the same temperature at the same time



OPERATION. Experimental setup for molding a propeller blank. The thermometer between the plies would not be used in manufacture. Intensity of waves is measured on the meter

bring wood up to temperature is dependent only on the power used. Steam platens sometimes take six hours to get glue-setting heat of 250 to 300 degrees through the plies. Radio does it in 15 minutes. And the astounding time saving is not all. The job is more satisfactory, too. In the steam-plate press for propellers, the surface heats faster than the inside. This may set up residual stress affecting strength. Radiothermics applies the same heat all the way through at the same moment, insuring perfection.

It works a marvel in the production of other laminations. Thick compressed and impregnated structures of wood, canvas, or paper that take up to 24 hours to complete with steam can be finished in 30 to 60 minutes by radiothermics. This means not only a saving in time and labor, but the simplicity of the heat application makes possible the use of less costly presses, eliminates the danger of damage by external heat, and allows greater leeway in design.

Radiothermics has thus turned the industrial spotlight on compregnated wood—itself a wonder child of wartime inventiveness. The process is started by impregnating hard maple or other hardwood veneers in a solution of water and water-soluble phenol resin under pressure in a vacuum. In 48 hours the resin embeds itself in the wood fibers; then the moisture remaining is removed by heating with the temperatures kept low to avoid polymerizing the resin.

Next comes the process in which radiothermics proves its worth. This is in laminating the veneers like plywood with the resin taking the place of glue. Impregnating, superheating, and pressing densifies the wood, changing its specific gravity to that of a molded plastic. Retaining the best fea-

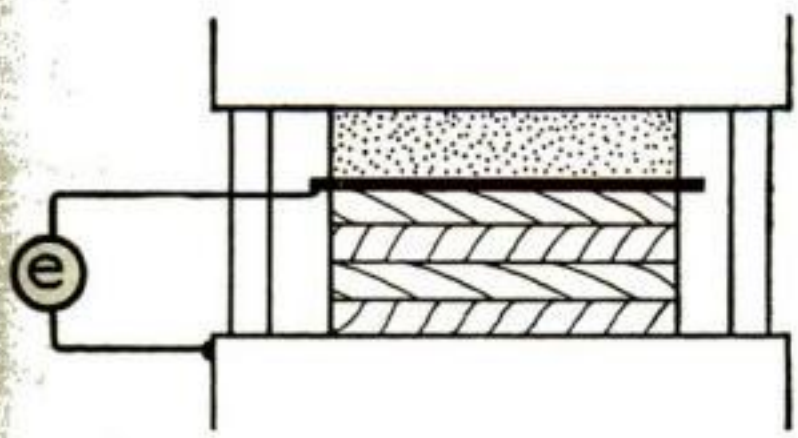


FIG. 3. Typical setup in which the bottom of the press is employed as one electrode. Insulation material above the other electrode prevents waste of power

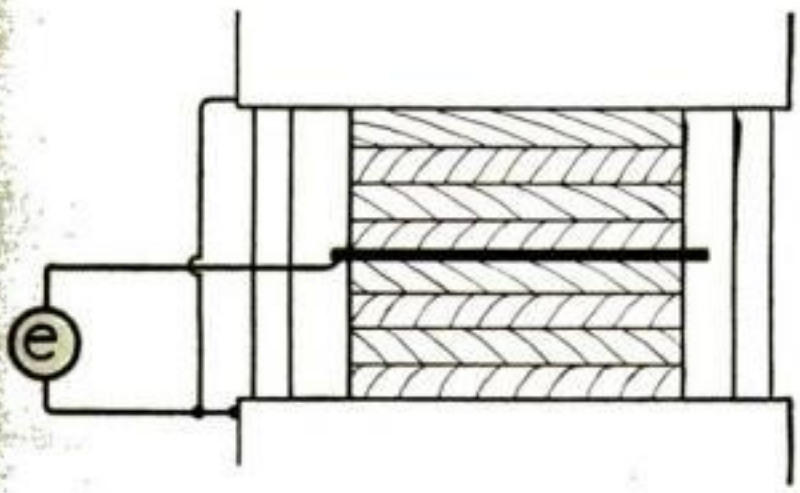


FIG. 4. "Sandwich" method of heating with two laminated-wood assemblies in the press at one time. The top and bottom of the press are connected as one electrode

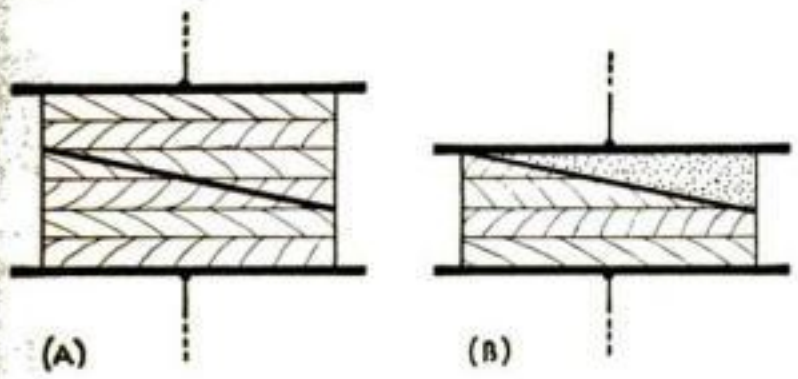


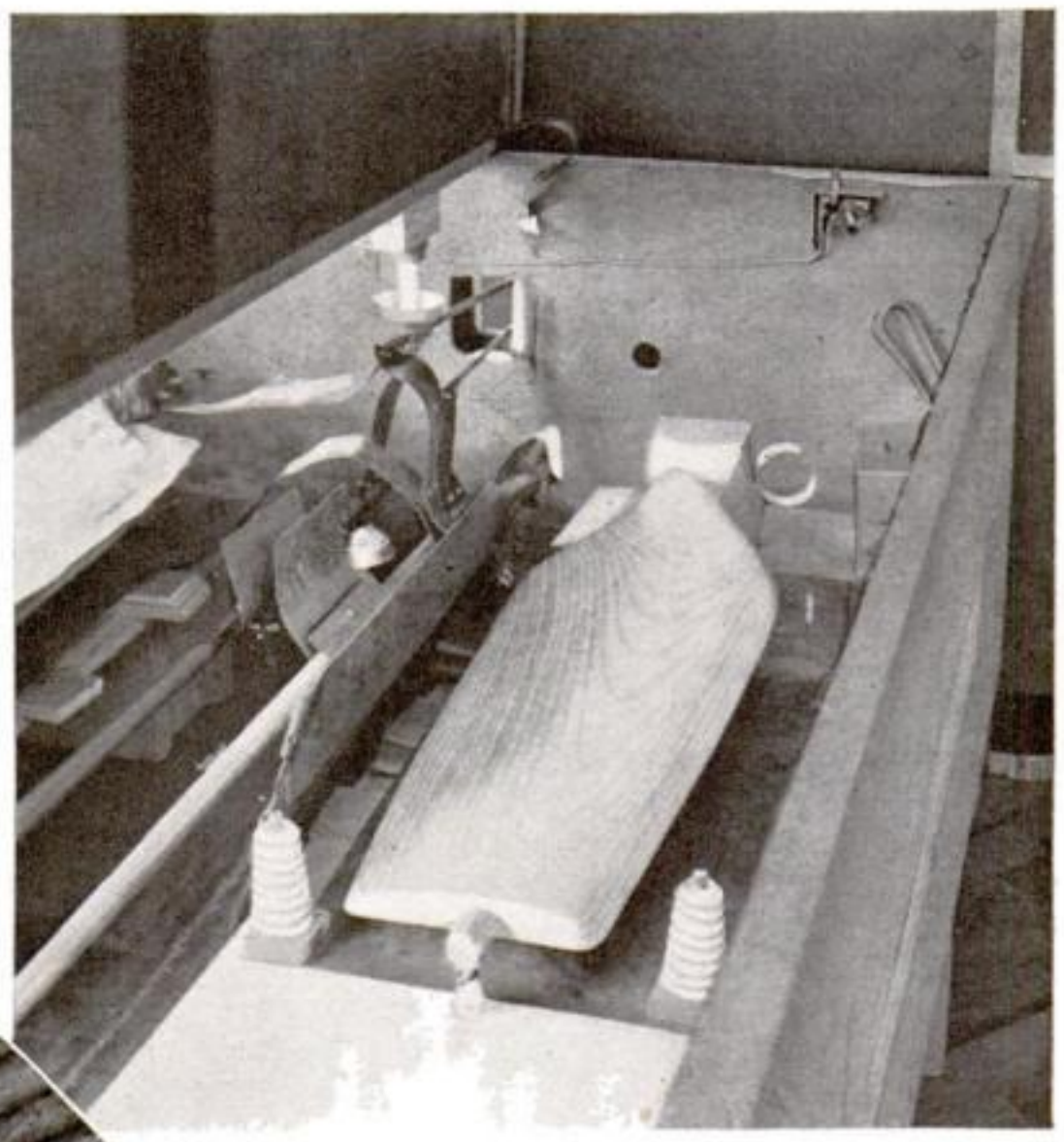
FIG. 5. Two methods of obtaining even radio-frequency heating of uneven pieces of material. Two assemblies are fitted together at *a*, and a spacer is used at *b*

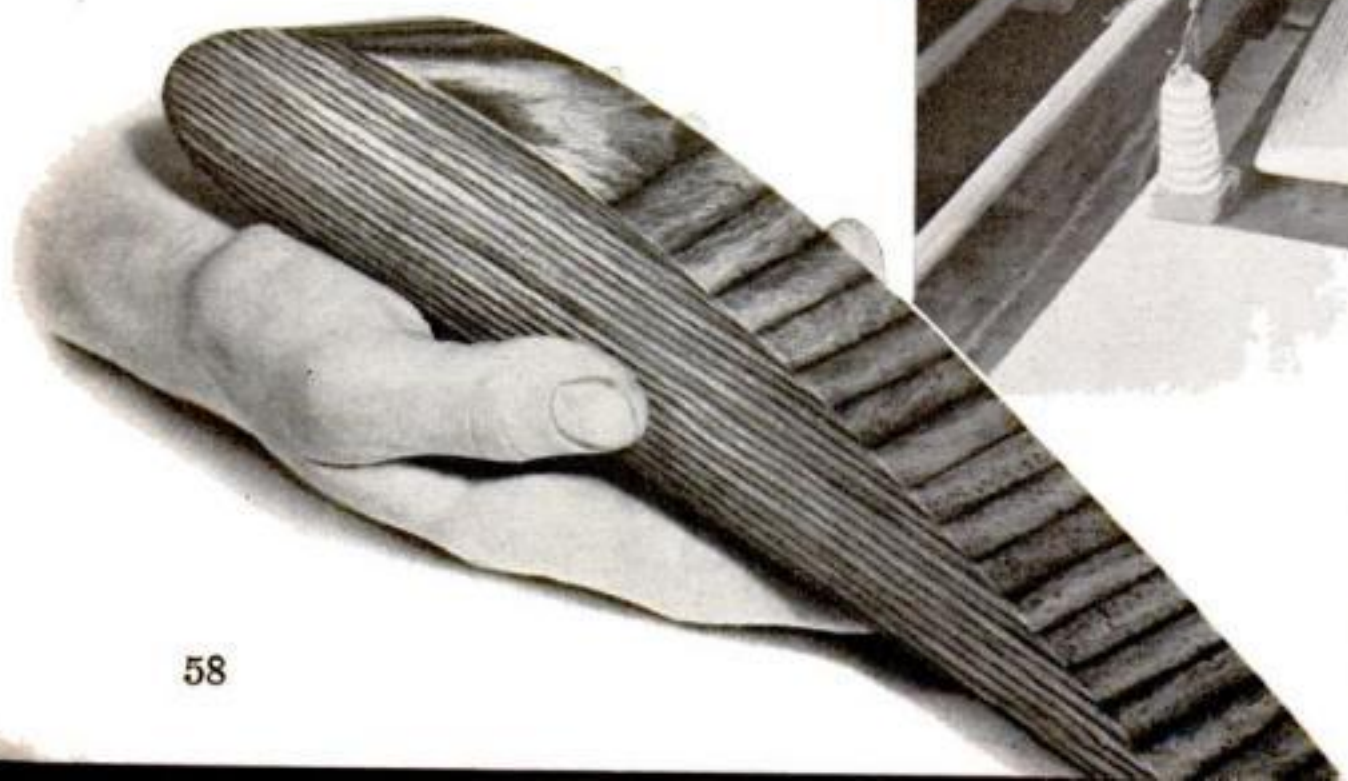
tures of wood and plastic, compregnated wood's strength-weight ratio is higher than that of any other wood composition and of many light metals. Steel dies impart to it a hard, polished surface, and the thermally set resin within it resists practically all moisture conditions.

Radiothermics is effective in the production of plastics in as little as a fifteenth of the time required by older methods, and it is believed that even more time will be saved eventually. The time saved depends on the thickness of the piece being produced. While the radio-operation time remains virtually unchanged despite thickness, simply by application of greater power, heating by other methods is slowed in proportion to the thickness.

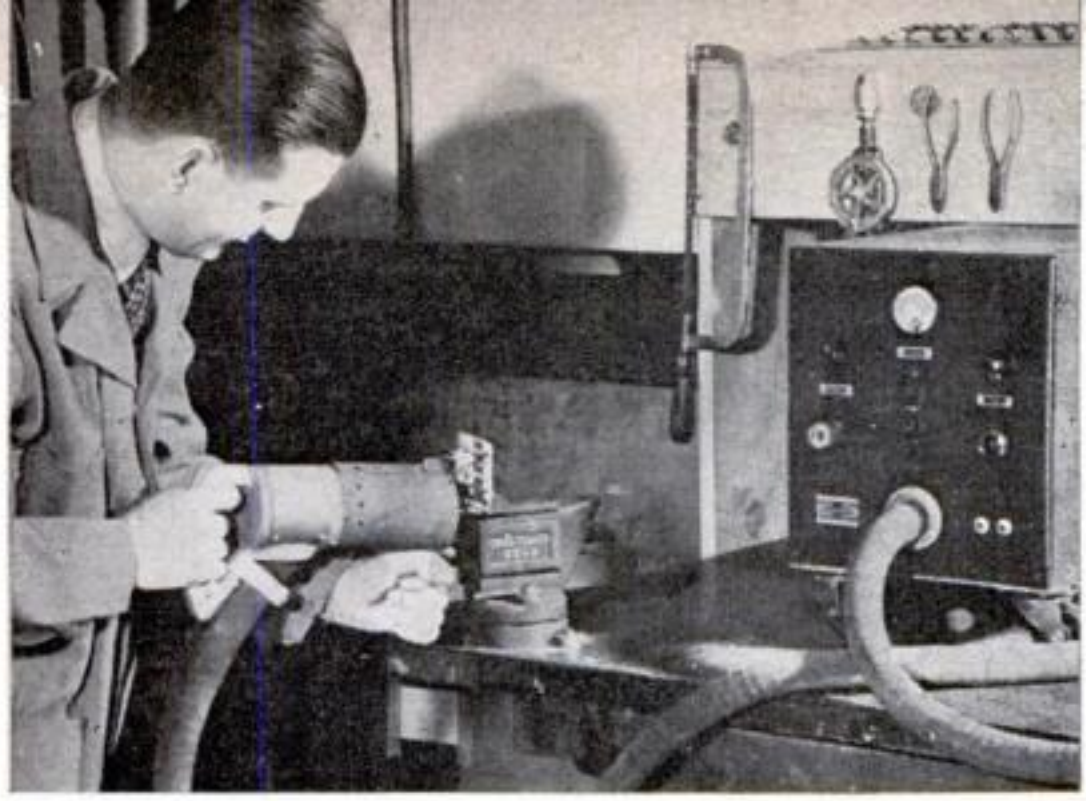
In making molded airplane parts of thick wooden layers, radiothermics becomes hammer and tack. Ordinarily each layer is fastened by small tacks or

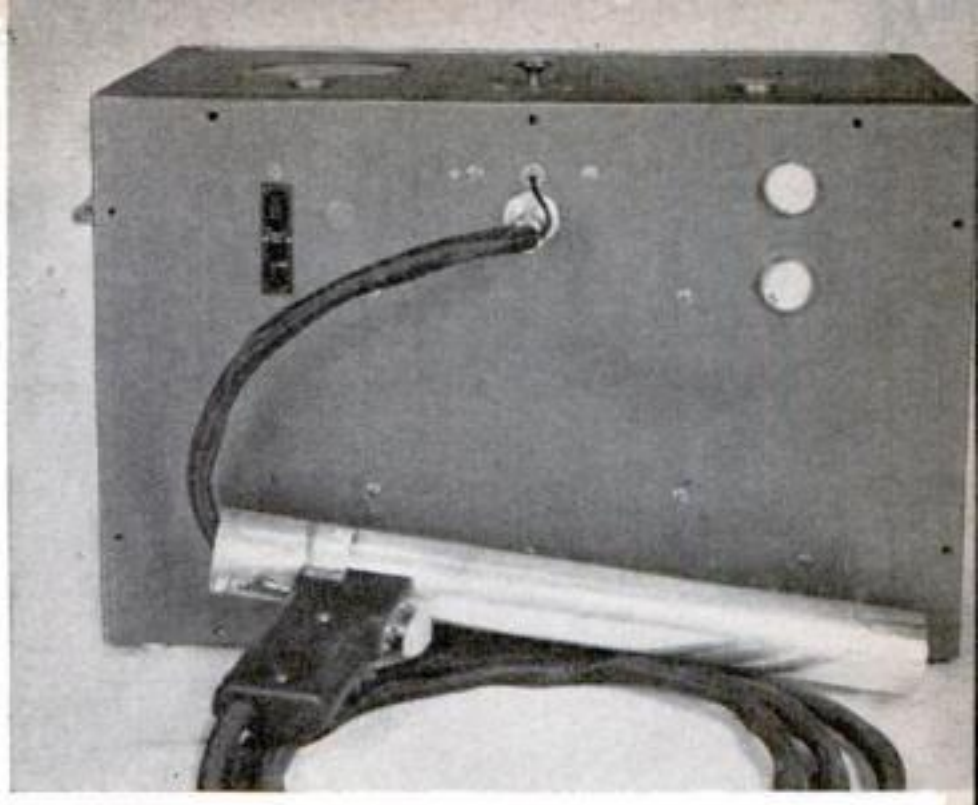
Short wooden strips placed all at one end, as above at top, give a blank a higher specific gravity at that end. The finished blank appears solid, as in the lower photo





COMPREGNATED WOOD. Impregnated with phenol resin, laminated wood is heated by radiothermics in steel dies to make test clubs, like that above, for the plane industry. The dies give the surface a hard polish similar to metal. At the left is a sample showing the cross section





PORTABLE MACHINES BRING RADIOTHERMICS TO JOBS

Radio-generated heat in this improved rivet gun will explode a charge in the head of a rivet much quicker than the method of applying heat by detonator irons

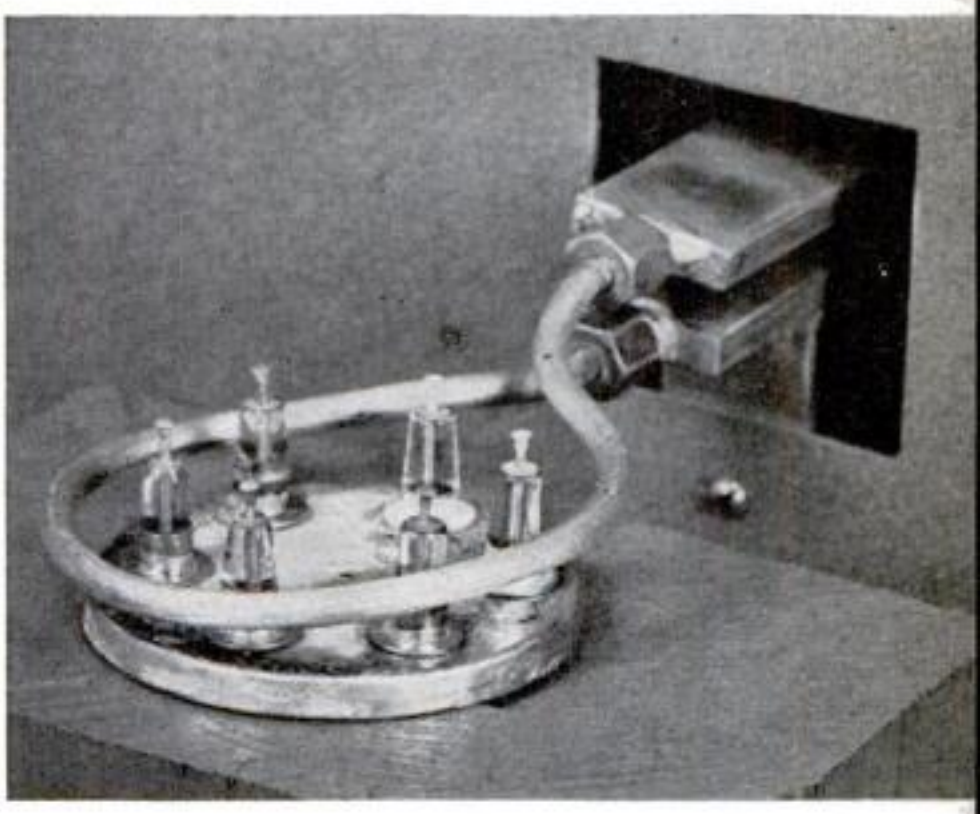
The "spotting gun" above heats glue at points between layers of wood to hold them together for final molding. Tacks were formerly used

staples to the mold. As successive layers are put in place, it is necessary to remove staples in the preceding layer. RCA engineers have discovered that the same results can be achieved simply by applying heat to small spots, and for this they have devised a self-contained "spotting gun." Its use causes the glue between the layers to form points of adhesion sufficient to hold the laminations in place until the final heat is applied.

Astonishing results are being obtained in soldering, brazing, welding, annealing, and melting metals by radiothermics. All of these, and even case-hardening, are accomplished merely by placing the metal in the field of the radio waves. The time of soldering operations is greatly reduced since the heat actually is induced in the part instead of being transferred from a hot iron or a gas flame. A dozen terminals on a transformer can be soldered in a matter of seconds. Cylinder walls, valve seats, and piston rings can be hardened with marked success.

One radiothermic oscillator, it is said, can cook as many as 1,000 hams in an hour. Others have been used to deactivate enzymes in fresh vegetables at a temperature of 180 degrees for quick freezing without loss of color or flavor. In one test RCA engineers deactivated nine dozen ears of corn and 60 pounds of string beans. The vegetables then were quick-frozen. Six months later they were unpacked and experts pronounced them more delicious than vegetables deactivated by the usual steam-heating method.

Radiothermics is being employed successfully in rayon-drying tests. The manufactured rayon, wound on spools, is known to engineers as cakes. Each cake weighs about three pounds, two thirds of which is water. Standard procedure is to place the cakes in ovens to dry gradually at a temperature of 140 degrees. Sometimes the outside of the cakes dries first. The resulting contraction dries the threads,

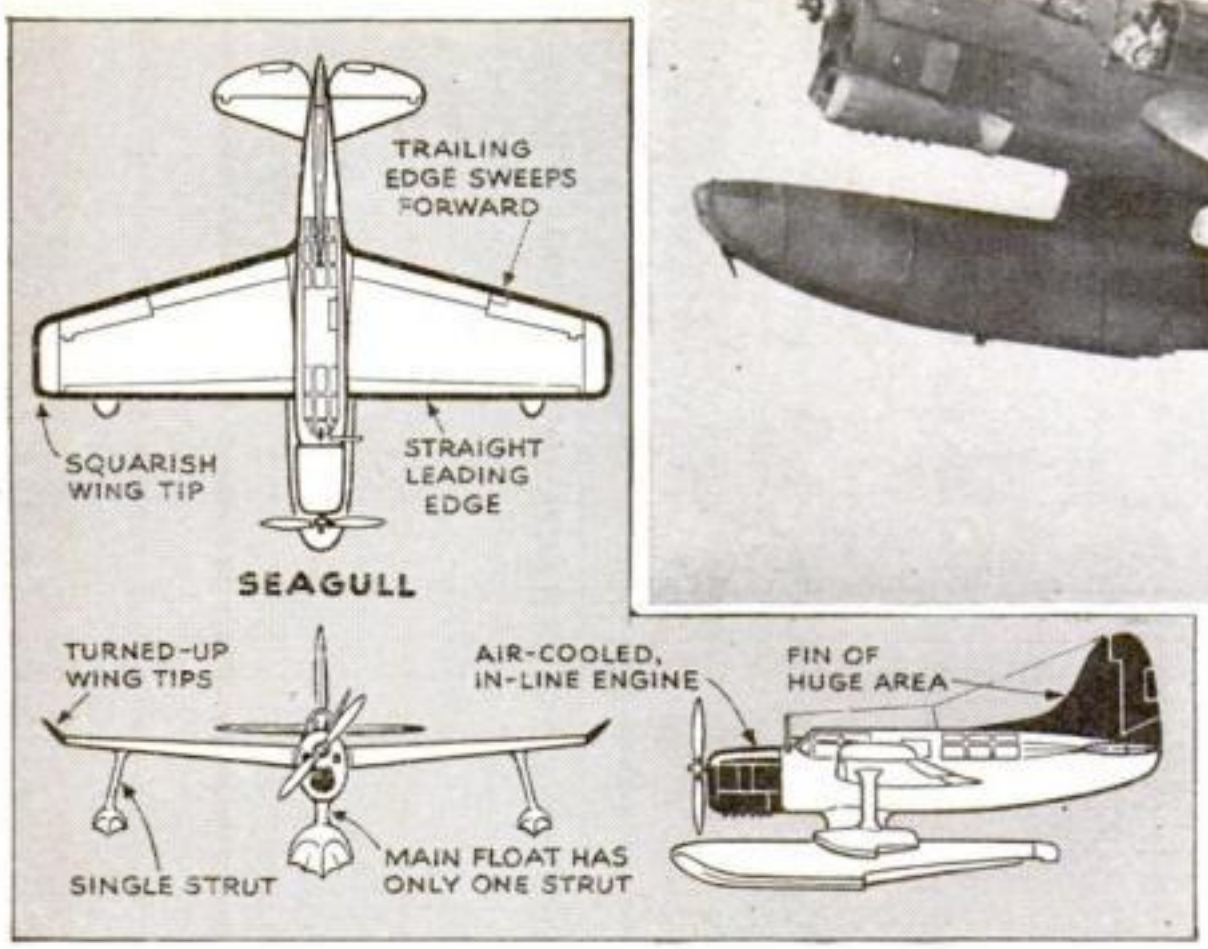


SOLDERING. Any number of terminals can be soldered in a matter of seconds with this radiothermic soldering iron. Controlled heat is brought to each point of contact at the same time, making the job a single operation instead of a separate one for each terminal

causes breaks in unwinding. The radio-dried cakes are uniform.

Still another application is speeding the setting of DuPont's ingenious exploding rivet for tight places and inaccessible parts. RCA and DuPont engineers have built a rivet-firing unit. It consists of an oscillator with a nozzlelike device which concentrates radio-generated heat in the rivet head. This fires the charge of explosive, expanding the end of the rivet into a perfect, barrel-shaped head.

Glue has found a new partner in radio heat. The result is a quick stitcher. It has been tried successfully on shoes, shirts, and sheets. In fact, there seems to be no end to the possibilities when this new jack-of-all-trades goes to work.



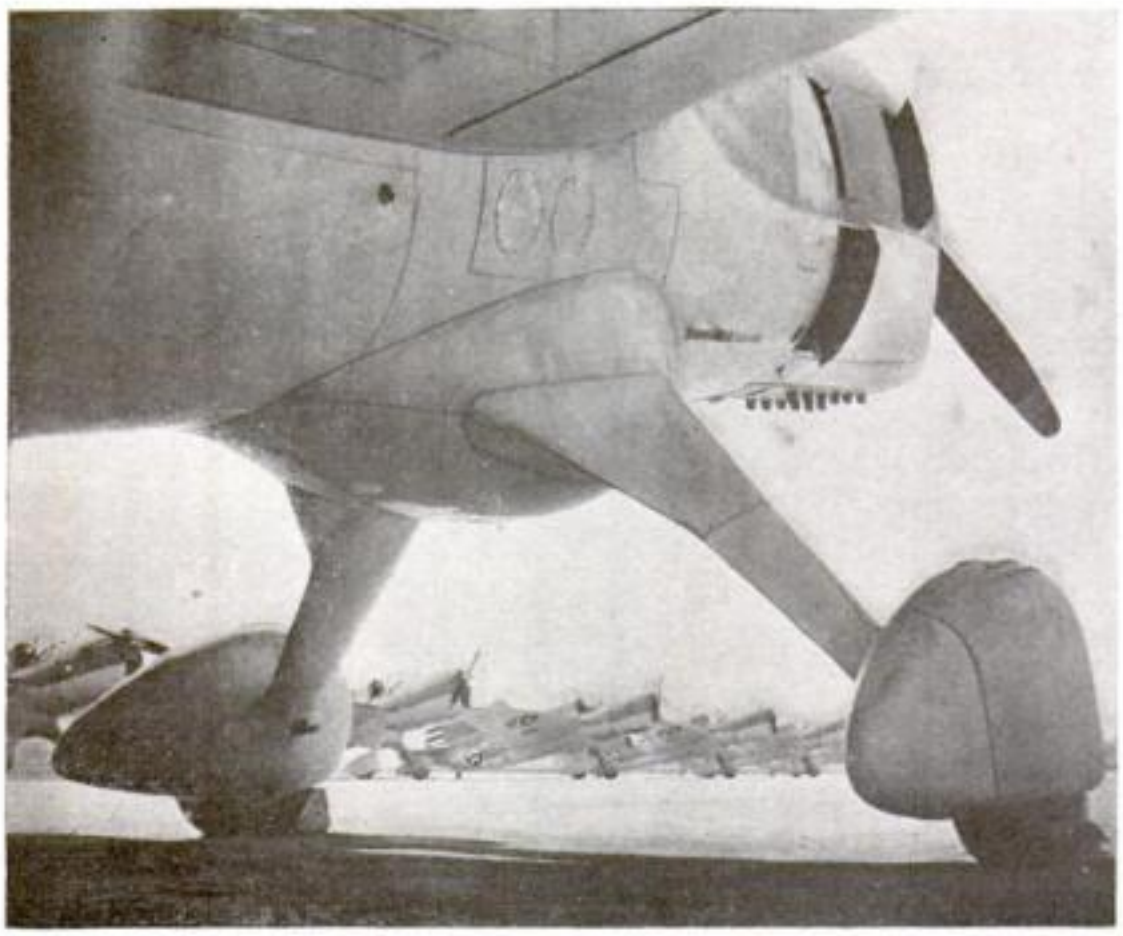
The Curtiss Seagull, one of the two standard types of observation planes in use by the U. S. Navy. Powered by a 450-hp. V-12 Ranger engine, it has a speed of over 175 m.p.h., 1,000-mile range

Slingshot Planes

GUIDE OUR FIGHTING SHIPS TO NEW VICTORIES

By WILLIAM S. FRIEDMAN

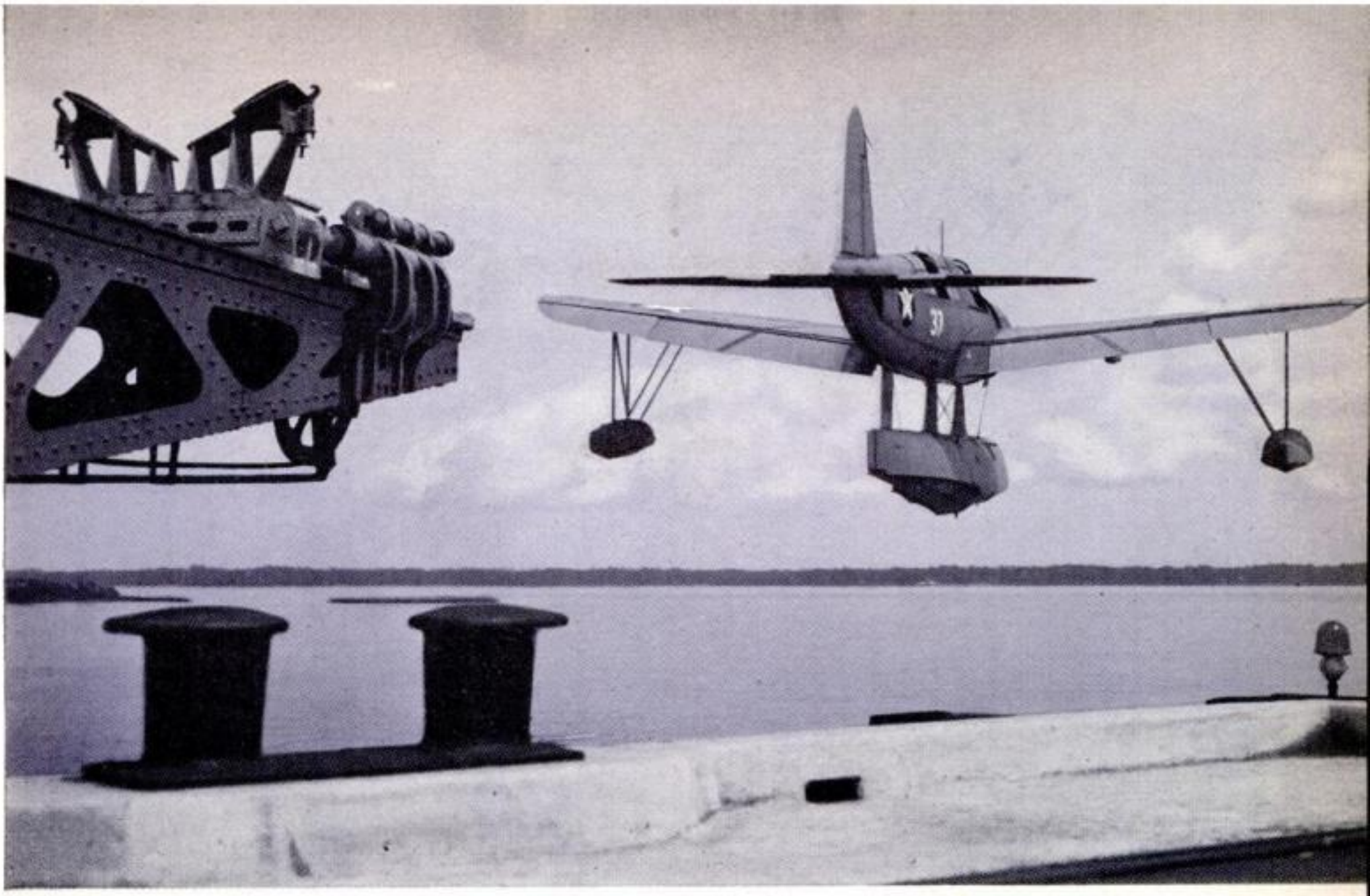
THE first job that aircraft had in any navy was that of looking around for the fleet. As soon as Glenn Curtiss landed his tiny seaplane alongside the U.S.S. *Pennsylvania* in February 1911, even the most shellbacked of naval sea dogs had to admit that the airplane was capable of outscouting any other observation device. Three years later, in the naval operations at Vera Cruz, when Lieutenants Bellinger and Towers spotted hit corrections for the warships *Mississippi* and *Birmingham*, aircraft's place as the eyes of the Navy seemed established.



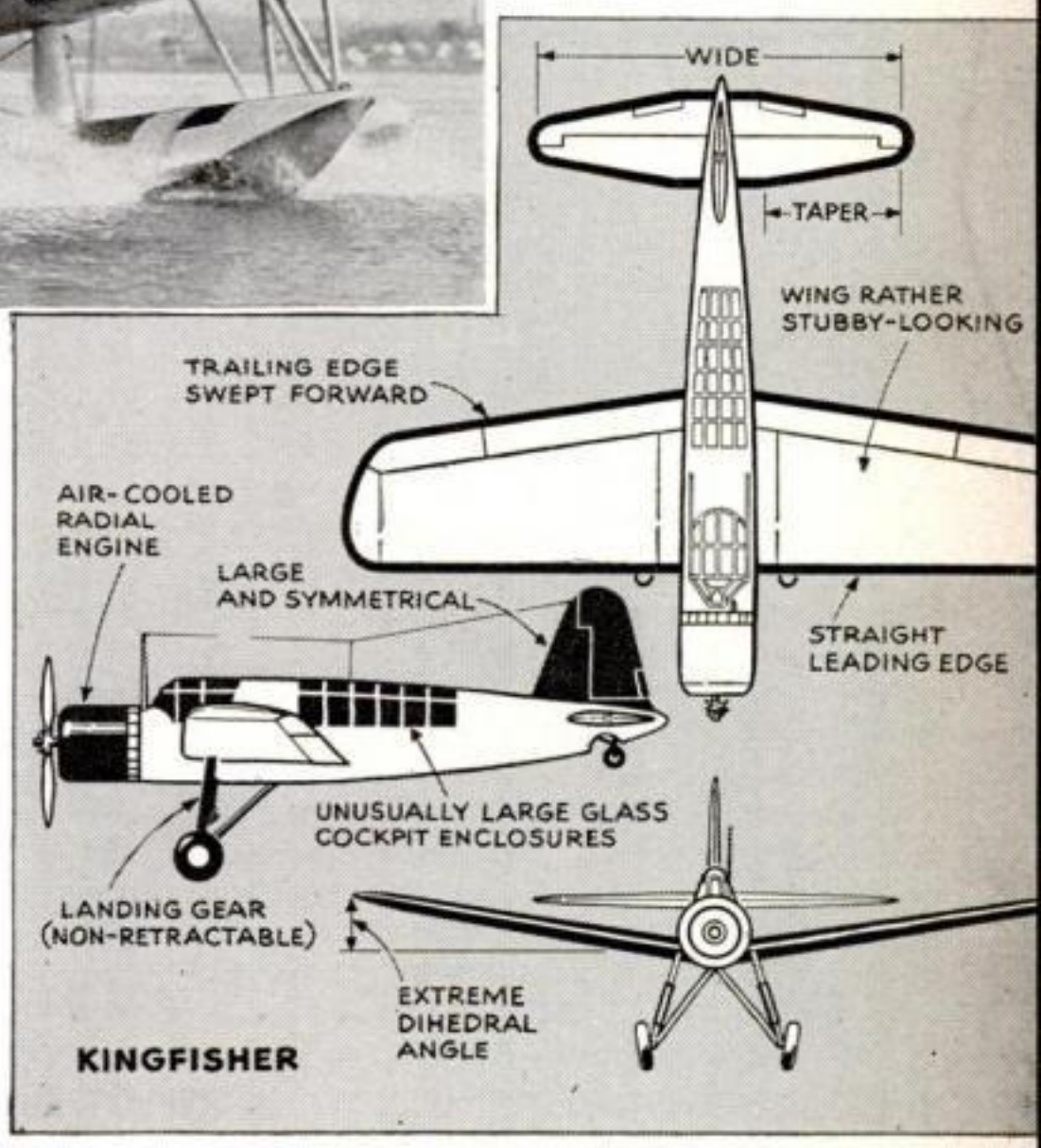
When used for offshore patrol from land bases, Seagulls are fitted with landing gear. Without the weight and parasite resistance of the center and wing-tip floats, they carry extra depth bombs

It was not, however, until 1919, when the lessons of World War I began to be digested and a workable catapult was perfected, that float observation seaplanes became standard equipment on all cruisers and battleships in the U. S. Navy. A special seaplane, the Vought UO-1, was designed for the work and the airplane became as much a part of the ship-of-the-line as the fire-control tower or the gun turret.

Observation units do two general kinds of work and their ships are classified by the letters VOS and VSO. "V" is the Navy's general classification for heavier-than-air. "O" stands for observation, "S" for scouting. Thus a ship catalogued VOS

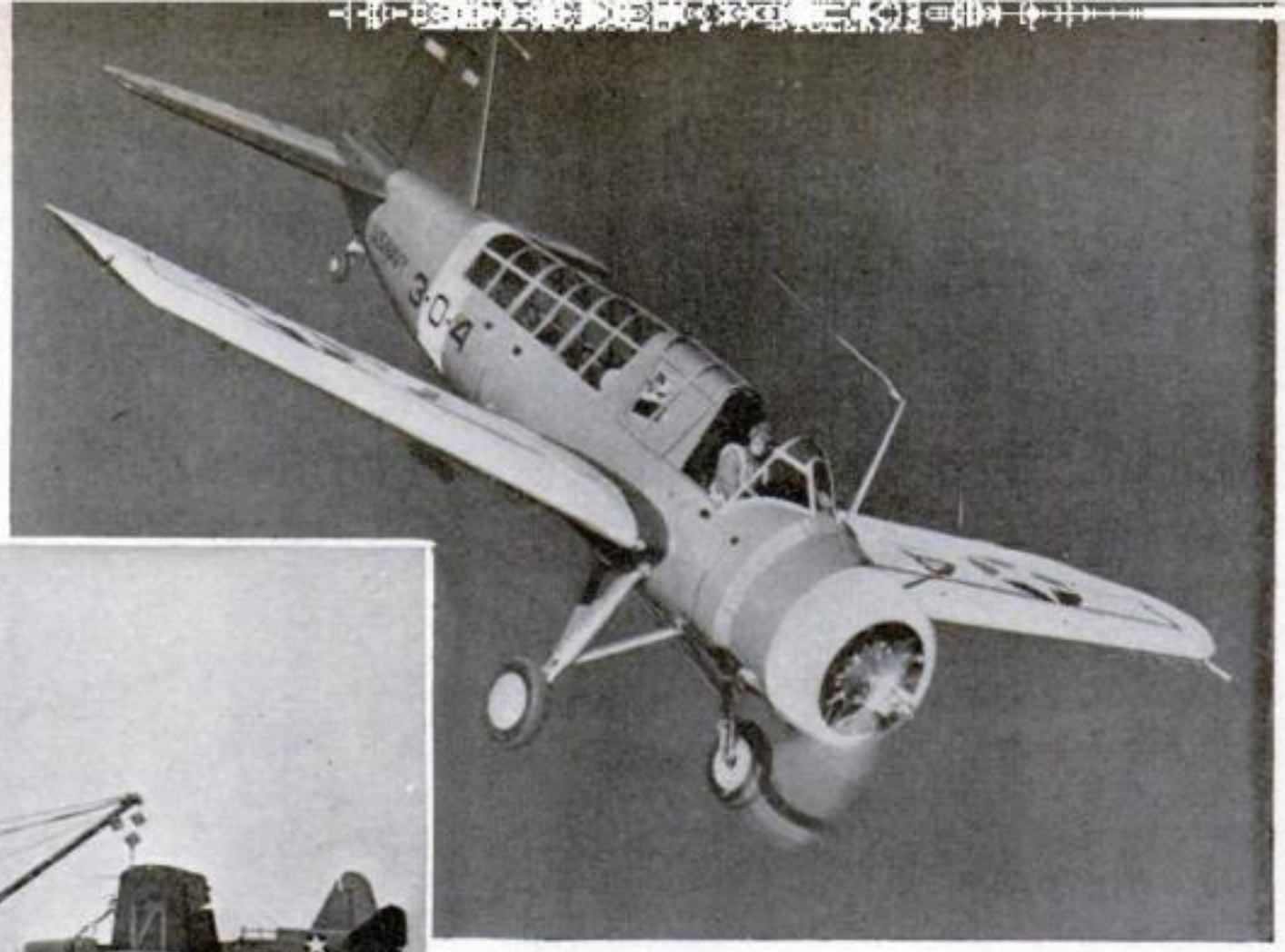


The Vought-Sikorsky Kingfisher, seen above taking off from a practice catapult, has a 450-hp. Pratt & Whitney engine. Top speed over 175 m.p.h. and range 1,000 miles. A plane of this type rescued Rickenbacker from his raft in the Pacific

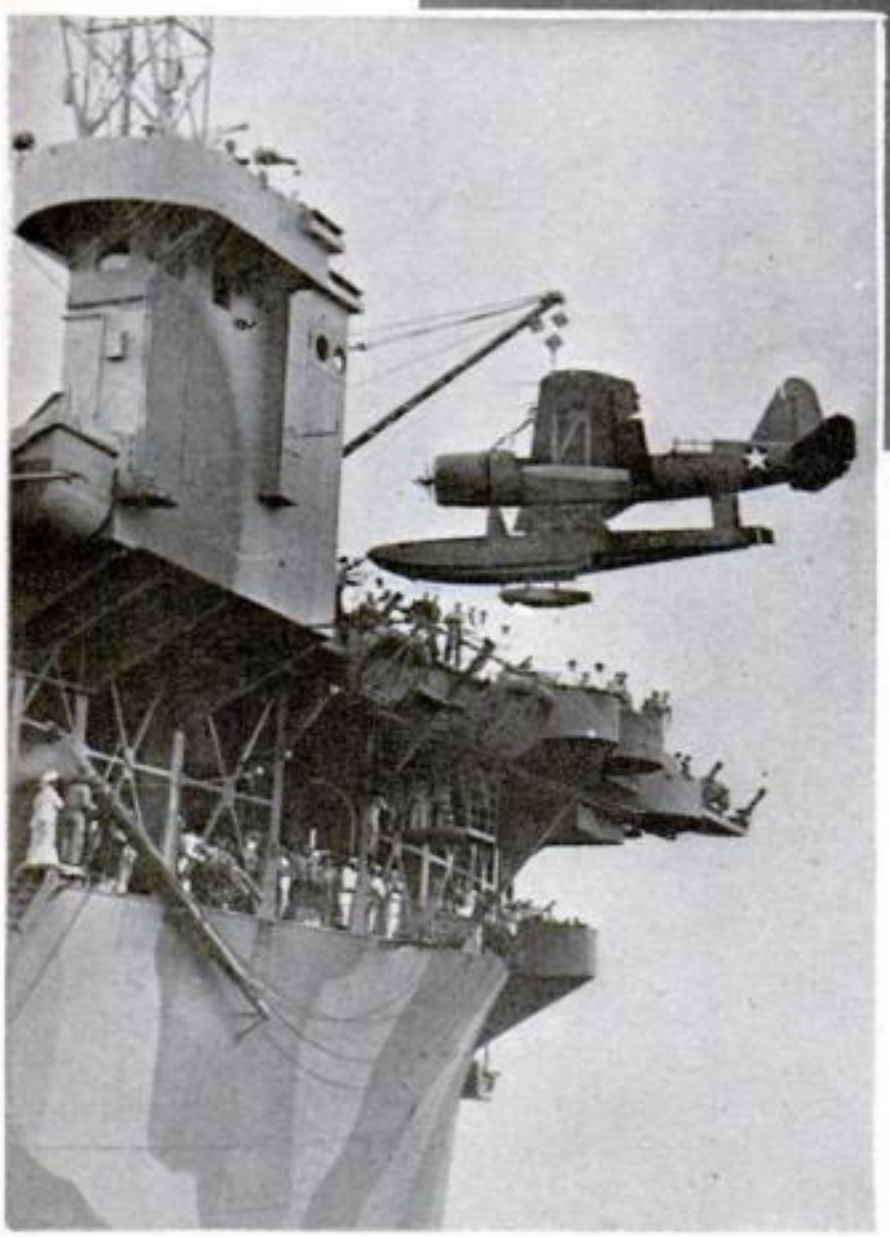


will be equipped primarily for observation, with scouting as a secondary duty. Its primary function will be to extend the field and accuracy of the main ordnance battery of the ship to which it is attached. In effect, it becomes an auxiliary fire-control station, placed higher than the ship and, when necessary, closer to the target. From data relayed from the plane by radio, the ship's guns can fire at a target they could not sight with shipboard fire-control equipment.

The job of a VSO plane is scouting—scouring the ocean for signs of the enemy and reporting his activity. In the old days, destroyers and cruisers did this



Land-plane version of the Kingfisher. Like the Seagull, this plane provides for maximum visibility, an important factor in its work of scouting, observation, and fire control



Here a Kingfisher is being hauled aboard a carrier after a scouting trip. The flat-tops use seaplanes to find the quarry for their fighters and bombers

job. Working on the surface, a fast vessel can scout an area 10 miles wide and 250 miles long in 10 hours if the visibility is five miles. The same ship, with four airplanes with a cruising speed of 120 miles an hour spaced ten miles apart, can cover an area 50 miles wide and 780 long in the same time.

This basic mission is frequently augmented by anti-submarine duty or bombardment, so the observation plane is equipped with racks for depth charges and bombs.

Of all the types of aircraft used by the fleet, the observation plane is, for its size, the most difficult to design. It is required to do more kinds of work and has the greatest number of engineering limitations. To begin with, its size is limited. It cannot have a wing span larger than the diameter of space allowed for catapult operation. Its wings must fold; its weight must not exceed the operating capacity of the catapult. Further, it must have a critical speed low enough to allow it to attain flying speed in the length of the catapult run.

To be useful as a scouting medium, the plane must have considerable range. With the size limitations, this can be achieved by using a medium-powered, economical engine. Actually, a scout-observation type is less powerful than an advanced trainer. It must have enough capacity for necessary operational equipment—radio, cameras, and some destructive and some defensive armament. Being, for the most part, equipped as seaplanes, they carry their water gear consisting of a main center float and two wing-tip auxiliaries which add weight and parasite resistance.

Add to the engineering complications the fact that the observation type is also required to be capable of landing in swells if necessary without regard to wind direction. The ship also must be made virtually corrosionproof, which robs it of more payload or performance. With all this, the scout must still retain enough performance to allow for defense against other aircraft. The current scout types are a fair approach to all these demands.

Frequently these characteristics in the plane, combined with combat judgment on the part of the crew, manage to be a fair substitute for gunpower, as in the case of an observation ship operating in the first phase of the African campaign. It was spotting for a cruiser when a group of three land-based fighters dived down on it. Feigning panic, the pilot ducked in and out of a group of broken clouds, dropping out of them directly over his ship. He pulled out at an altitude that gave the cruiser's anti-aircraft gunners a perfect target. After the fighters were properly polished off, the

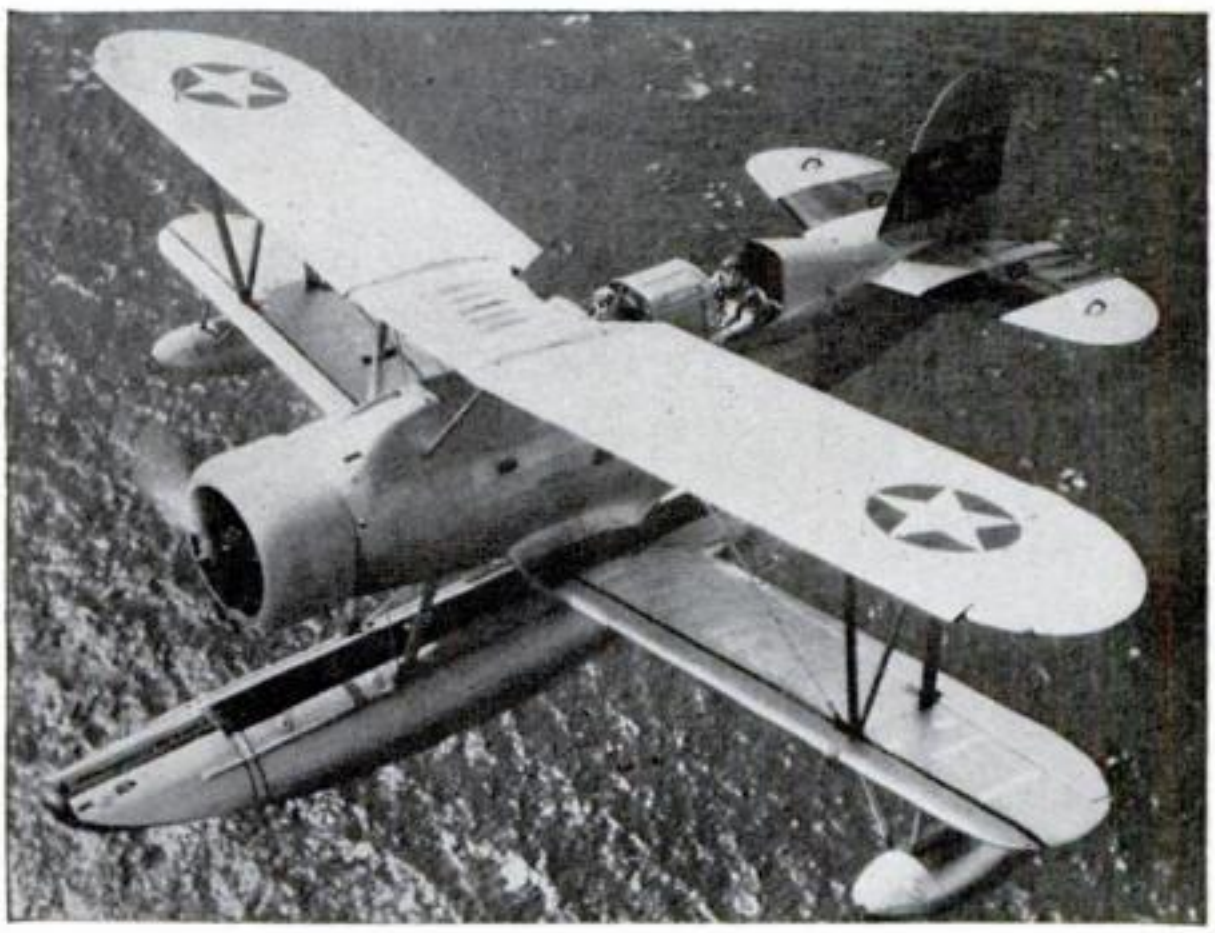
scout went about its business again, spotting hits.

It should also be remembered that we owe one of our most brilliant naval victories in the Solomons to a VSO ship. Flying several hundred miles into enemy waters, the pilot spotted a Jap task force heading for the Solomons. Despite harassing fire, he climbed out of range and radioed the information to his base ship.

No part of the fleet's air strength is more a part of the real, saltwater Navy than the observation units. Fighters, bombers, and torpedo planes are, in a sense, merely passengers on a carrier. Observation craft are more a part of the surface vessel, and their pilots must be qualified as deck officers and gunnery experts. They must know fire-control and ordnance limitations, so that they can observe and relay fire-correction information. They must know naval tactics, so that they can understand and interpret the shifting pattern of naval operations and provide the surface commander with information needed for successful deep-water operations.

There are two new types of observation craft in ordinary use, although several older types are still in active service. One is the Vought-Sikorsky Kingfisher, the type that effected the Rickenbacker rescue. It has a wing span of 36 feet; its seaplane version is 33 feet, 10 inches long. Powered by a 450-hp. Pratt & Whitney Wasp engine, it has a top speed of over 175 m.p.h. The range is about 1,000 miles. The other, the Curtiss Seagull, has a wing span of 38 feet and is 35 feet, eight inches long. Powered by a 450-hp. V-12 air-cooled Ranger engine, it has a top speed over 175 m.p.h and a 1,000-mile range.

When you read in your newspaper that our fighting ships have met the enemy anywhere on the high seas, you may be sure that the slingshot planes were in on the scrap, spotting the foe and bringing in vital information to make the victory sure.



An earlier Seagull, the Curtiss SOC, is powered by a 500-hp. Pratt & Whitney Wasp engine, has a cruising range of about 675 miles at 167 m.p.h. Note the Handley-Page slit in upper wing to aid catapult take-off

The predecessor of the current production Seagull was the XSO3C-1, shown below. It had a 450-hp. Ranger engine and a conventional wing. Observation planes are moderately powered for long range with small size

WING INSIGNIA OF UNITED NATIONS AIRMEN

WINGS are the symbol of birdmen all over the world, for obvious reasons. But there are differences in insignia which reveal nationality, branch of service, and specialty. Here are some of the insignia worn by members of the various air forces of the United Nations

Air gunner of the Royal Air Force

Pilot of the Royal Air Force

Flight engineer of the Royal Air Force

Pilot of the Royal Canadian Air Force

Pilot of the RAF Ferry Command

Pilot of the RAF from South Africa (service bar)

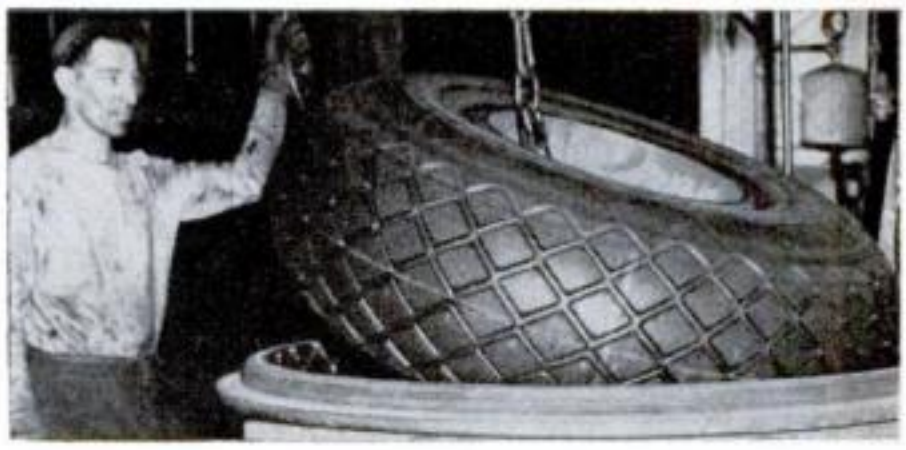
Pilot of the United States Civil Air Patrol

Pilot of the Czechoslovak Air Force

Pilot of French Air Force

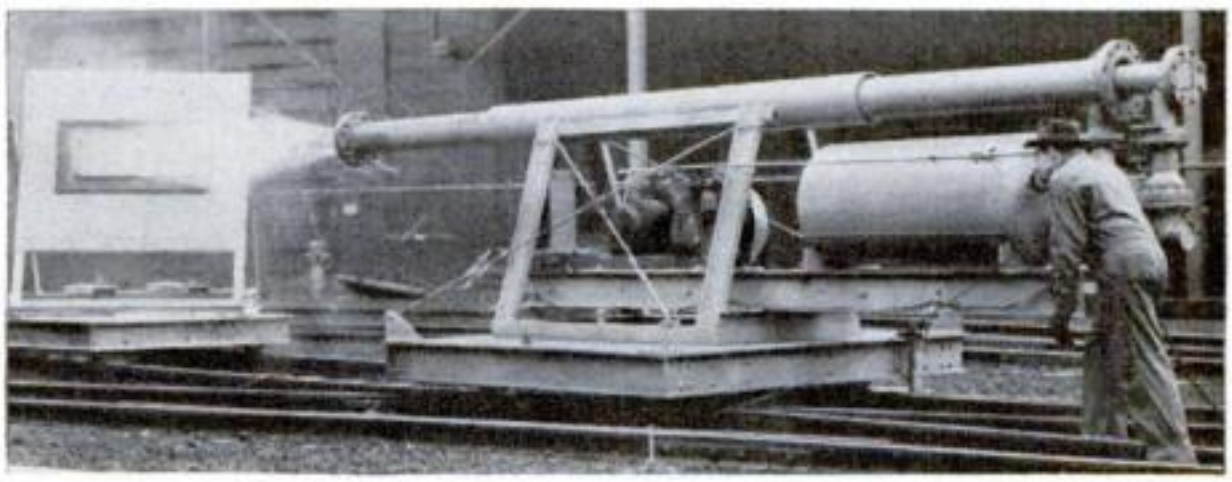
Pilot of the Royal Norwegian Air Force

HELICOPTERS are being made for the Army by the Vought-Sikorsky company as the result of successful tests on an experimental model. Although this type of craft is limited in speed and lifting power, it has the great advantages of being able to rise and descend vertically, fly either forward or backward, hover motionless over a given spot, and operate from land, water, snow, or thin ice. Because of its ability to "hang" in the air, it is effective for observation.



BUILT-IN TIRE CHAINS are increasing the traction of the Goodyear Diamond nonskid tires used on Army planes. Designed for high-speed landings and take-offs on small fields covered with ice or snow, the new tire has embedded in its tread thousands of spiral metal rings that supplement the diamond tread. The rings may be seen in the carcass of the tire, at the left. Above, the finished tire is taken from its mold.

A BIRD CANNON operated by compressed air, shooting dead 15-pound turkeys, through the air at 200 miles an hour, is used to test birdproof windshields for Army planes. Shields combining tempered glass and resilient plastic have been found to withstand the test.



Answer to Air Power

BETTER AA GUNS ARE SHOOTING ITS SUPREMACY FULL OF HOLES

THE prophets of air power, from Douhet to De Seversky, have had their innings in this war. Armies have been swept away, great warships have been sunk, and cities have been battered into ruins by relatively unopposed air armadas. The argument seemed to be clinched. "Give us enough planes," said the all-out air enthusiasts, "and you won't need any ships or soldiers."

But it is an axiom of war that every new weapon calls forth a counterweapon to neutralize it. For air power, that counterweapon is antiaircraft artillery. Better guns and more of them, on land and sea, are turning the tide. Air power still is, and always will be, a potent weapon—but no longer is the airman the cock of the walk.

In the following article Allen Raymond, famous war correspondent who has seen the ack-ack in action on the Pacific front, gives you the facts about this latest revolution in the ancient art of war.

By ALLEN RAYMOND

THE supremacy of the airplane as a weapon of attack on military objectives is passing its peak. The rising might of antiaircraft gunnery, massed, mobile, and directed by mechanisms that have taken human errors out of gunfire, has already proved that military forces on land and sea are defensible against onslaught from the air.

Ack-ack downs airplanes. The tide in favor of defense on land and sea as against attack from the air began to turn demonstrably in September 1942. Astounding successes of antiaircraft weapons, once the joke of most airmen, were increasingly reported in February 1943.

Brigadier General Hermon F. Safford, chief of the Production Service, Office of the Chief of Ordnance, reported February 15 that one United States Army multiple-gun motor carriage in North Africa had downed nine enemy aircraft. This carriage transported two .50 caliber machine guns and a 37-millimeter automatic cannon, mounted coaxially. One enemy plane had been shot down while the carriage was still on a lighter, and another while it was in a sea train during landing operations against attack from the air. Seven were downed when this mobile ack-ack unit reached shore.

A single battleship, until recently called useless against massed air power by the more fanatical followers of the prophet Billy Mitchell, has downed 32 Japanese dive bombers and torpedo planes in the Southwest Pacific, and successfully accomplished her mission unscathed.

On February 10, 1943, Congressional leaders were told that our war supplies for Russia were getting through to Murmansk in greater quantities than ever, with almost none of the shipping losses that occurred before the autumn of 1942. The reason for

1.1–IN. "CHICAGO PIANO"

MODERN NAVAL VESSELS

To avoid the fate that overtook the British warships *Repulse* and *Prince of Wales,* naval vessels now bristle like hedgehogs with a wide variety of antiaircraft weapons. At the left, gunners man a 1.1-inch multiple pom-pom aboard a U. S. cruiser that took part in the African landing operations. At the right are two 40-millimeter Bofors automatic cannon mounted together. At far right, a row of 20-millimeter Oerlikons lines the flight deck of a flat-top. Besides the AA weapons that crowd the decks and superstructures of regular fighting vessels, "flak ships"—floating antiaircraft batteries —specialize in fighting off enemy air attacks

An American three-inch AA gun in action somewhere in Australia. Our crews have made good there

this was told in the U. S. Naval Institute Proceedings for February by Rear Admiral H. G. Thursfield of the British Navy.

Describing the arrival of a September convoy at Murmansk, after fighting off successive attacks by German land-based planes, the Admiral said: "This operation demonstrates that it is not impossible, by means of shipborne aircraft and the fire of ships' guns, to provide an effective umbrella even against massed attacks by land-based air forces. It was clear that, on the whole, defense had mastered attack. Bomber and torpedo aircraft have not yet achieved mastery of sea traffic."

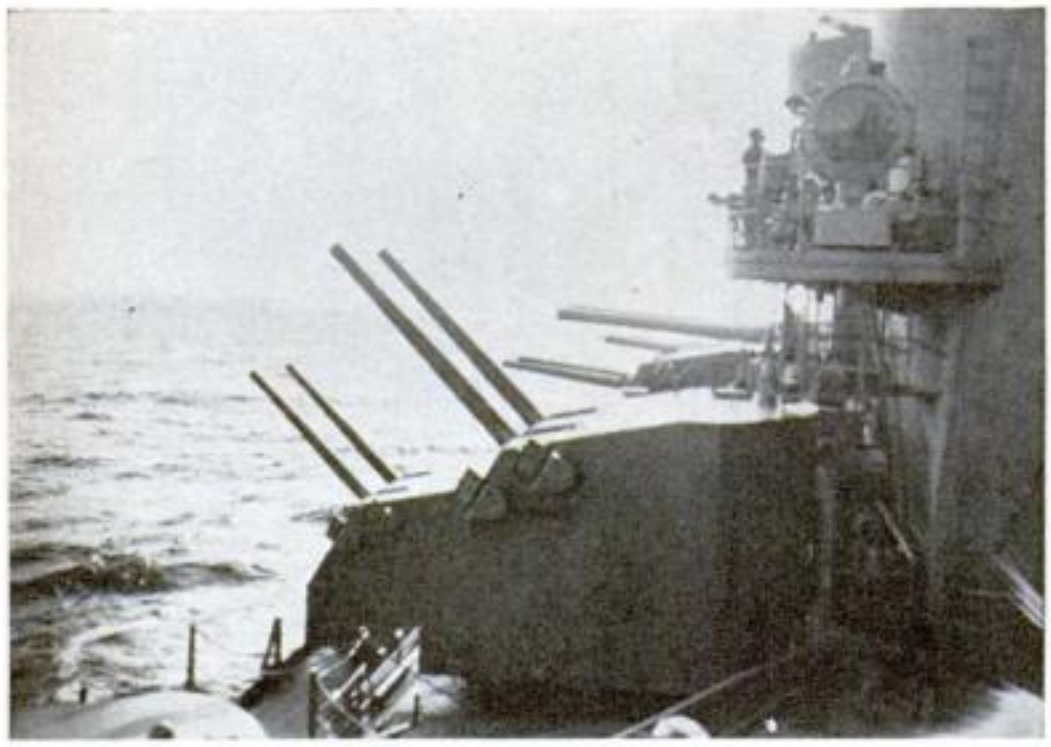
What is changing the balance of war between the forces of land and sea and air? Antiaircraft gunnery of an accuracy and volume that were nonexistent when the Japs attacked Pearl Harbor and sank two British warships off Malaya. A battery of United States Army 90-millimeter guns in the Solomons has downed one Japanese plane for every 50 shots fired—a rate too fantastic to be sustained. Downing one plane in 10,000 shots was a miracle in World War I.

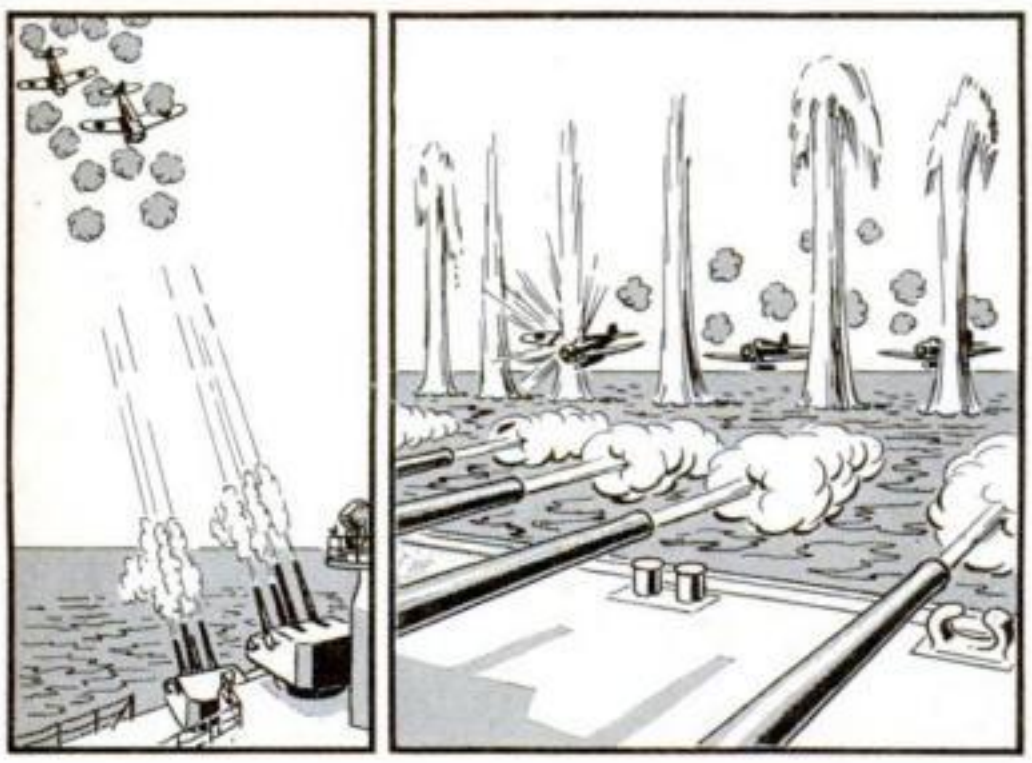
Three factors are primarily responsible for this sensational increase in the power of ground gunnery against the air.

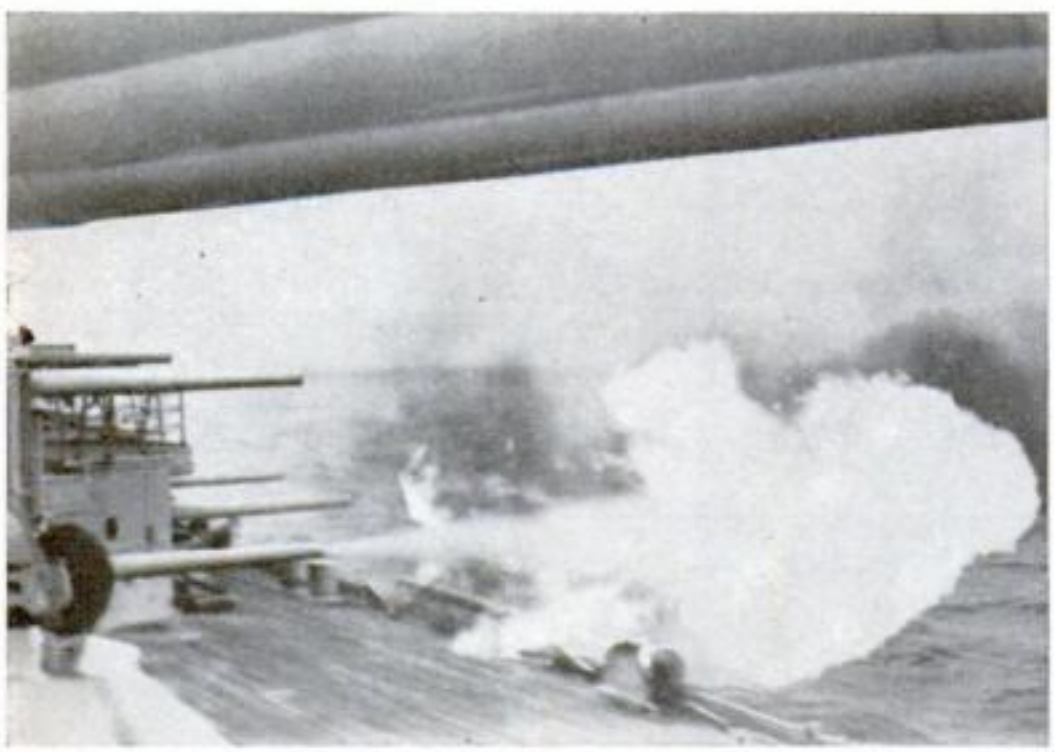
1. Scientists in research laboratories and

CARRY THEIR OWN UMBRELLAS OF ACK-ACK FIRE

Guns up to Five-Inch Size Fight Off Planes at Sea







DUAL-PURPOSE GUNS of large caliber wing dive bombers on the downswoop, and throw up columns of water with their shells to stop torpedo planes flying in low. Photo at top shows our largest naval AA guns, five-inch 38's mounted in pairs on one of our new battleships. Above, these secondary-battery guns let fly to make water hazards for torpedo planes

factories have made more progress in the last 18 months than in many years in developing electric and mechanical aids to accurate gunnery against targets moving too swiftly for men to hit them unaided.

2. The industrial systems of all the combatant powers are turning out these new developments in mass quantities.

3. Military leaders have changed their ideas of antiaircraft fire from the tactics of merely stationary defense to those of mobile attack as well. They are now content no longer to await the onslaught of hostile aircraft upon their own installations. They are making their antiaircraft equipment highly mobile so it may be sent out airplane hunting, just as men with faith in their guns go out to hunt big game from blinds or ambush.

The details of scientific advance in mechanical direction of gunfire are military secrets in every na-

FOR CONVOY WORK, dual-purpose guns like this three-inch naval rifle are mounted on merchant ships. It can be used with equal effect against aircraft, subs, and surface vessels

tion. The fact of the advance is not.

On January 23, the *New York Times* published a dispatch from its London correspondent, James McDonald, telling of the rising power of defense against aircraft in both London and Berlin. "The British," he said, "have developed a co-ordinated system whereby ground gunners and day and night fighters . . . . make things distinctly unhealthy for enemy bombers. Witness the fact that 15 German raiders were shot down in the last raid, ten percent of the force that came over.

"Berlin is so strongly defended that when British airmen are briefed to go there they whistle under their breath. They don't relish the assignment."

Owing to new mechanisms, which will measure how far away a plane may be, the direction of its flight, and its speed with an accuracy impossible for human beings, anti-aircraft fire is becoming increasingly automatic. These data, plus necessary corrections such as lead computation for aiming ahead of a moving target, can be transmitted by electric impulse to machinery which actually can aim and fire the guns.

Scientific progress in directed gunfire has now given ground forces weapons of adequate quality for their job. Providing them in mass for ships and troops is now under way. When our first convoys went overseas, they were almost naked of ack-ack weapons, as compared with what they carry today. The very guns had not been manufactured. Today our naval vessels and armed merchantmen bristle like hedgehogs. There are rows of .30 caliber and .50 caliber machine guns on many of our merchantmen, as well as heavier weapons. Some of these .50's are fired in pairs from a single mount.

Escorting naval vessels also carry 20-millimeter Oerlikons, two-barreled Bofors, four-barreled 1.1-inch cannon (known as "Chicago pianos"), three-inch and five-inch cannon of high velocity. Most of these larger weapons have all the electric and mechanical aids for range finding and lead computing that have been pouring from American, British, and Canadian factories.

The gunwales of some of our battleships, cruisers, and aircraft carriers are literally lined with rows of these weapons, and more have been jammed into other positions on superstructures. "Flak ships," devoted solely to antiaircraft protection, have supplemented flagships. Naval practice, then, is proving that the answer to dive bombers and torpedo planes, which enthusiastic air-power advocates once said had doomed the battleship, is a devastating volume of ack-ack. They have shown that an almost impermeable curtain of accurately aimed and controlled fire may be set up over military objectives, through which airplanes cannot pass without terrific casualties.

The power of German antiaircraft gunnery supplements the *Luftwaffe* in protecting Germany's war factories, submarine bases, railroad yards, and other military objectives. Because of the two, combined, Cologne still functions, as a factory center, though bombed 112 times up to February 3, 1943. The Nazi submarine base at Lorient had been bombed 65 times up to February 9, and the naval base at Wilhelmshaven 71 times up to February 12.

Great block busters laid flat large areas. The military objectives must still be destroyed. Dispersed, camouflaged, buried under masonry, protected by curtains of fire from antiaircraft weapons and the lethal wires from barrage balloons, they carry on.

Opinion within the United States War Department concerning the value of ground gunnery against airplanes has advanced so far within the last two years that the Antiaircraft Command is one of the fastest-growing arms of the service. Originally organized under the Coast Artillery Corps, Antiaircraft now far exceeds the size of the parent organization. Under the command of Major General Joseph A. Green, with headquarters at Richmond, Va., it is offering an opportunity for troops in its ranks to train for front-line service around the world. Antiaircraft weapons and tactics are being modernized so fast that there is constant change in techniques.

Camp Davis, Wilmington, N. C., is one of the principal training centers. A cantonment costing $17,000,000, its quota of officers is at least 20,000 graduates yearly. There are seven other unit training centers. Lieutenant General Lesley J. McNair has announced that our antiaircraft forces will double this year their total in 1942.

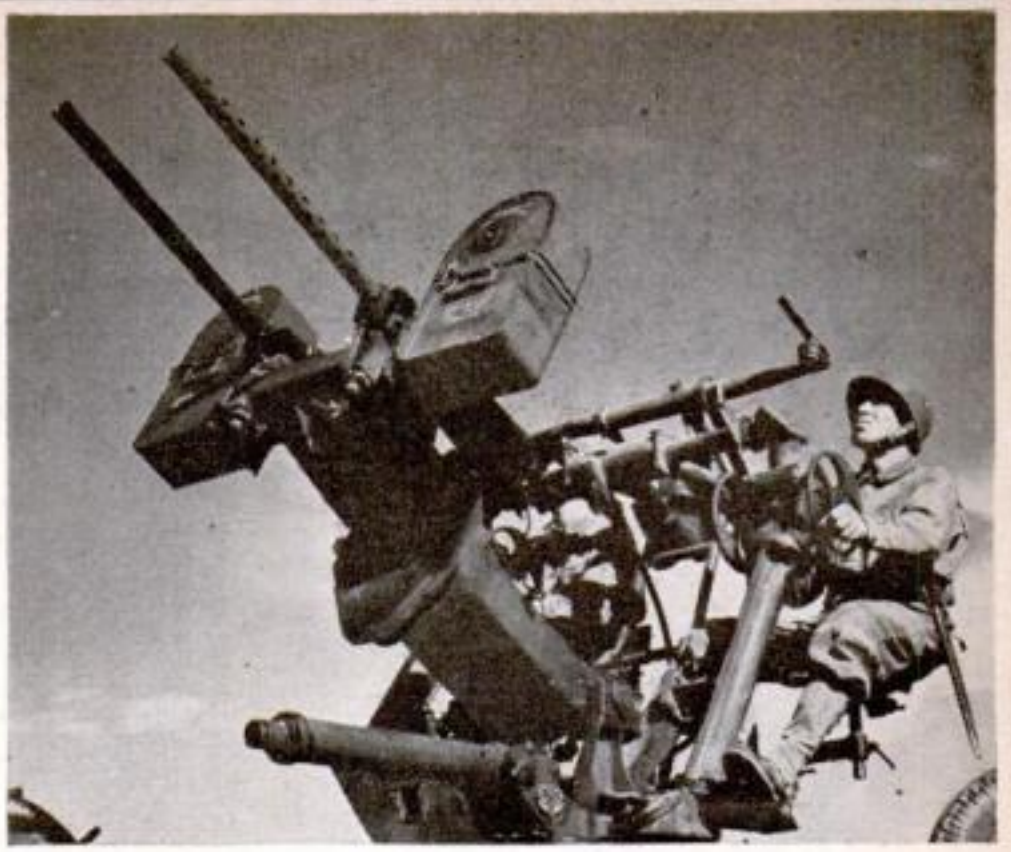
In the standard 90-millimeter gun, these forces have a weapon of great effectiveness at more than five miles. The gun was a blueprint in 1937. There were fewer than 50 guns made when war broke out.

Today we are exporting them to our allies. This is a magnificent weapon. It is a big cannon, more than 15 feet long, firing about 24 pounds of high explosive almost six miles. These shells explode on a time fuse set automatically by the fuse cutter according to the altitude, speed, and direction of the target, calculated by mechanical means. As they explode, they spray metal upward and outward. The concussion of such a shell, exploding within 100 yards of an airplane, is enough to knock a pilot unconscious or kill his motors.

For automatic weapons we have the 40-millimeter Bofors and the .50 caliber machine gun. This Bofors has a vertical range

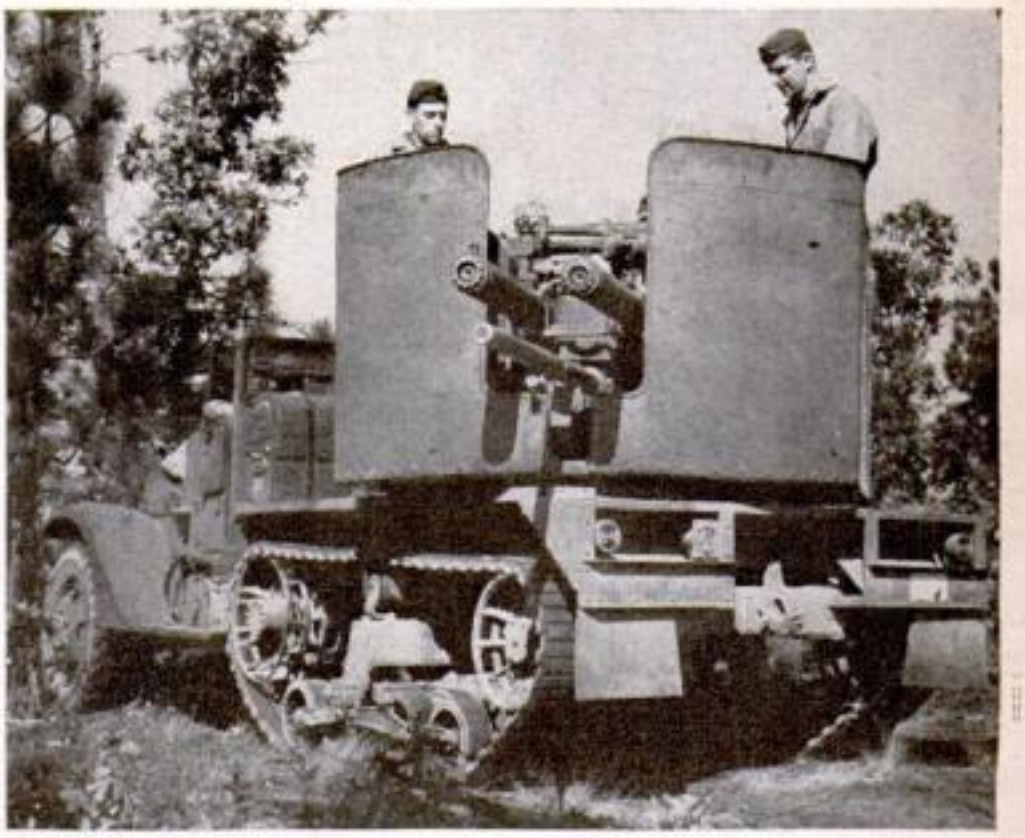
MOBILITY PUTS GUNS WHERE THEY ARE NEEDED TO PROTECT TROOPS

On its welded high-speed carriage, this Bofors gun can be placed quickly where it is needed. With its director it forms a self-contained mobile AA unit



Two .50 caliber machine guns, coaxially mounted, can be carried on a truck or half-track, right with the front-line troops and wherever a tank can go

This machine gun on a jeep represents the Army's new thinking: AA protection goes wherever troops go. Can be fired in motion or with the side drop



Two .50's and a 37-mm. cannon, coaxially mounted on a half-track as a self-propelled weapon, give a three-in-one greeting to attacking dive bombers

MASS PRODUCTION PROVIDES QUANTITY FOR KILLING FIRE POWER

It isn't enough to have the best guns in the world: you have to have a lot of them to give every combat unit and every vital area its umbrella of fire. That's where mass production comes in—turning out the guns in greater numbers than anybody ever dreamed of before. At the left, workers in a war plant are putting the finishing touches on a three-incher. On their skill and care depends the usefulness of the gun when it is set up for action as shown below. In the 28 days of February, American factories turned out 2,000 AA guns

of more than four miles. Its projectile weighs 2¼ pounds and is fed into the magazine in clips. It can fire easily 120 to 140 shots a minute. All its shells are tracers.

The .50 caliber machine gun fires 500 to 600 rounds a minute, traveling 2,700 feet per second, with one bullet in five usually a tracer. Its armor-piercing bullets will penetrate a half inch of steel. One shot in New Guinea went through a palm tree 18 inches thick, and through the steel helmet of a Japanese soldier. Hundreds of thousands of these guns are now being provided American armed forces to protect them against dive bombers and low-flying aircraft.

While these three guns are standard, the Army has an even bigger cannon on the way, which will down planes in the stratosphere.

Less than a year ago I stood under a tree near an airdrome in Port Darwin, Australia, and watched some Australian antiaircraft gunners bring down two Japanese planes in flames. It was beautiful gunnery, and lovely fireworks as the enemy came tumbling down ablaze. Yet those Australian gunners were using a height finder which all the nations at war are trying today to replace, and which all are using occasionally—including our own.

This height finder, a complicated 13-foot tube, mounted on a tripod, is a marvel of optical design, with many shiny glass prisms, wedges, lenses, and shiny steel gears and differentials. Three men manipulate it, and until a few months ago it probably represented the greatest advance in range-finding apparatus in modern warfare. Soon it will be as extinct as the dodo.

For all its prisms and gears, its accuracy depends ultimately on a peculiar quality of eyesight in the human "height-finder observer" commanding it. This is called stereoscopic vision, or stereo-acuity. The quality, found most frequently in baseball, tennis, and handball players, is that of judgment of distance. A man who is a good observer one day is a bad one another, just as a home-run hitter in one inning strikes out in another. Mechanical measurements are now being substituted, gradually, in major-league warfare. Height-finder ob-

THIS IS A GERMAN AA GUN

The Nazis' antiaircraft equipment is inferior to ours, if this 7.92-mm. machine gun is a fair sample. Army Ordnance officers who examined the captured piece at the Aberdeen Proving Ground in Maryland found both tripod and gun to fall short of American standards. German ack-ack is still, however, a formidable obstacle

AUTOMATIC CONTROL BRINGS MORE-THAN-HUMAN ACCURACY IN AIMING

At the director station (1), trackers keep telescopes on target for elevation and azimuth. Height finder (2) finds the plane's altitude. Firing data automatically computed are transmitted electrically to the gun (3) where gunners set the piece accordingly and the automatic fuse setter (4) times fuses

servers, being human, are on their way out.

When I was at Port Moresby, less than a year ago, Jap planes successfully strafed Australian planes on the ground and in the harbor. An American ack-ack officer, returned from there recently, told me that once our antiaircraft batteries were installed, the Jap planes were driven upward until they never bombed at lower than 22,000 feet. When the flak was too thick, they jettisoned their bombs before reaching their objectives. Then they fled. In four months at Port Moresby, after installation of American ack-ack, American ground forces lost not a single man from enemy air attack, and the Australians only four men.

Defensively, then, we are proving our ability to drive enemy planes upward and away from restricted military objectives, and to diminish the effectiveness of their bombing and machine-gunning. The next great advance in the use of ack-ack is going to be in offensive tactics, and this will be an American innovation in warfare—just as the blitz by armored vehicles was of American origin theoretically, but first exploited by the Germans.

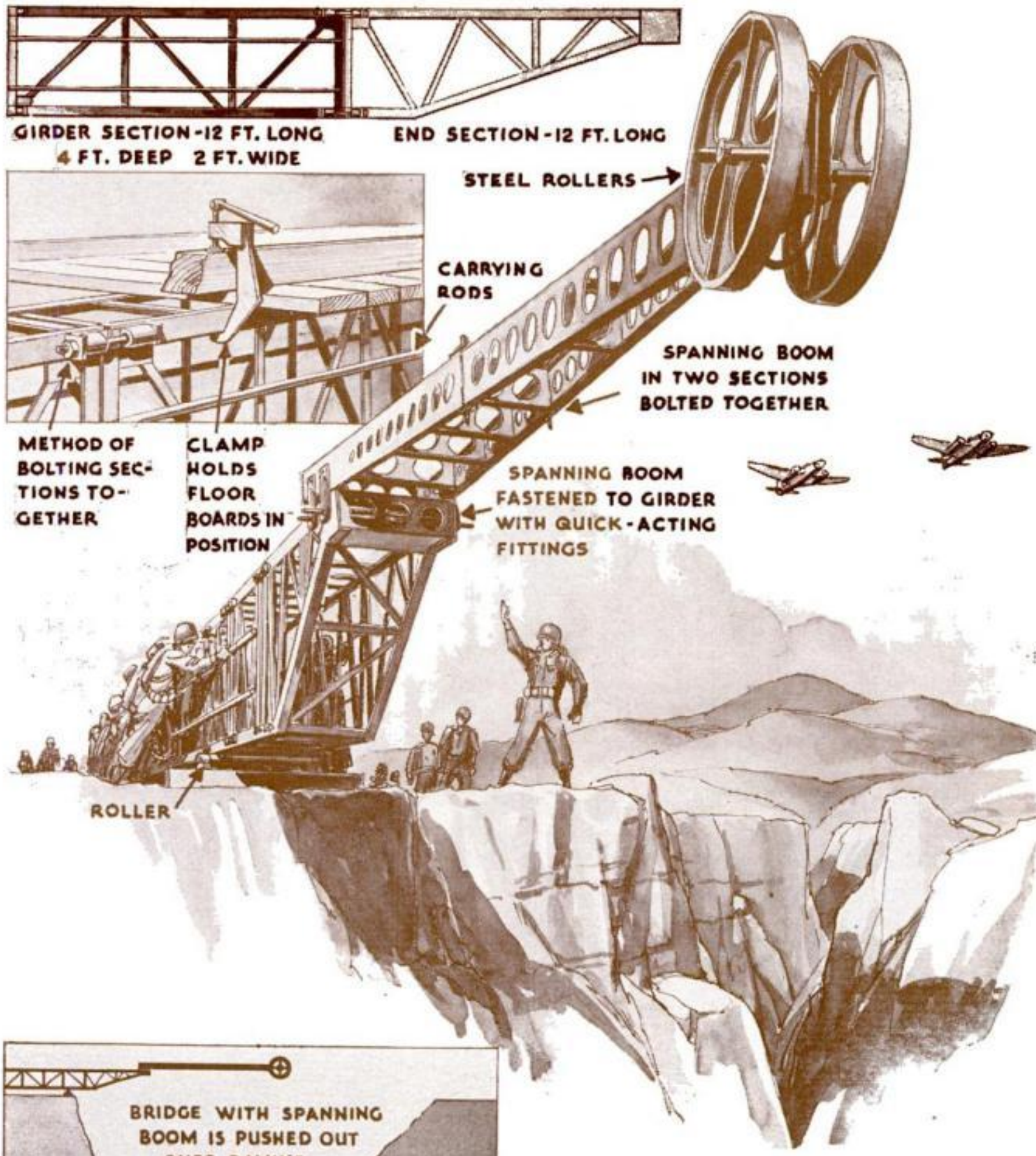
When Major General George S. Patton arrived in North Africa last November, he quickly improvised there a mobile ack-ack battalion to go forward in the fight accompanying our armored forces. He simply put automatic antiaircraft guns on self-propelled mounts—on trucks, jeeps, and half-tracks. With such a lead the future course of these tactics is sure.

Mobile ack-ack units will serve with all branches of the Army ground forces—infantry, engineers, and mechanized cavalry. Specially designed trucks, tractors, and other motor vehicles, capable of carrying the guns over any terrain, will be strung along the lines of march between bases and the fighting fronts, going forward as the troops advance and retiring as they withdraw. Two, four, or even six guns may be mounted on single vehicles.

Tactically, advanced antiaircraft batteries will be found just behind the reconnaissance units in moving forward, and remain with the extreme rear guard in any withdrawals. These ack-ack units will be used to protect engineers in building bridges or strengthening old ones; pro- *(Continued on page 214)*

Army's New Tank Destroyer Rules the Battlefield

A LAND CRUISER that can trade blows on even terms with the famous German 88-millimeter tank gun is one of the latest additions to America's mechanized might. The new tank destroyer is being built on a volume basis at the tank arsenal of the General Motors Fisher Body Division, and its welded construction has benefited by Fisher's experience in building the welded M-4 tank



Portable Steel Span Takes 10-Ton Load

PORTABLE steel bridges, capable of supporting 10-ton loads, are used by U. S. troops for quick crossings of ravines and narrow streams. Each bridge consists of two lattice steel girders on which wooden flooring is laid. To place a girder, a launching nose fitted with wheels is attached to the end and 20 men shove it on rollers across the gap. When it topples down, the wheels carry it up the opposite bank where a second crew sets it in an abutment of earth and wood. Ravines as wide as 108 feet can be spanned in one or two hours.

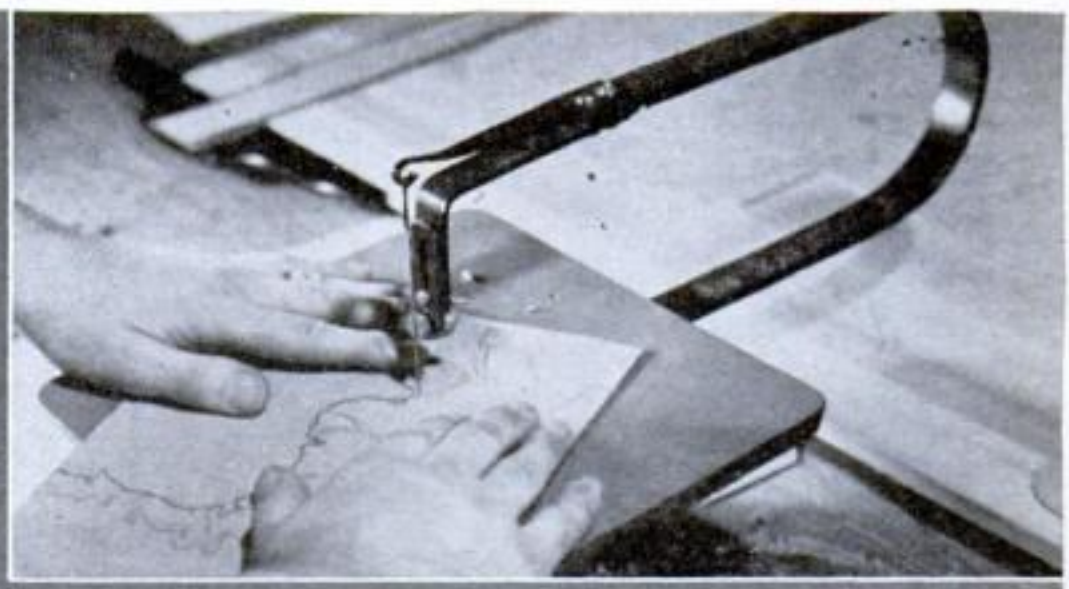
RELIEF MAPS

Explain Strategy of Global War

HERE'S HOW THESE ACCURATE PLASTER MODELS ARE MADE

First step in making a relief map is to photograph selected physical maps in several sections, making enlarged prints to the scale of the desired relief model. Contour lines on these photographs, showing various elevations of land, are then traced, one level at a time. These tracings will serve as guides to establish levels on the finished map. Here workers are tracing contours in the Red Sea area

Each tracing is imprinted, by means of carbon paper, on a sheet of cardboard. The cartographer also traces guide lines of the next higher level on the same cardboard to show its proper position



On a vibrating jig saw, the traced outline is cut out of the cardboard sheet. The lighter lines that appear in the photograph are the guide lines which will mark the place for the lamination for the next higher level

With a well-finished oak platform as a base, the map maker builds up the relief by tacking on the cardboard segments. Small brads are used in close work, staples where larger areas make it possible

Now the sculptor-cartographer works soft, puttylike plastolene over the built-up cardboard layers. Referring constantly to the printed maps, he shapes the mountains, valleys, and plains to accurate contours

When finished, the plastolene model is framed with wood and varnished for a hard finish. Over the varnish coat, talc is brushed on carefully in preparation for making the permanent plaster cast from it

To make the matrix or negative cast, hot gelatin glue is poured on from a bucket in which it has been melted over a fire. Glue must be hot in order to allow trapped air to rise easily from it in bubbles

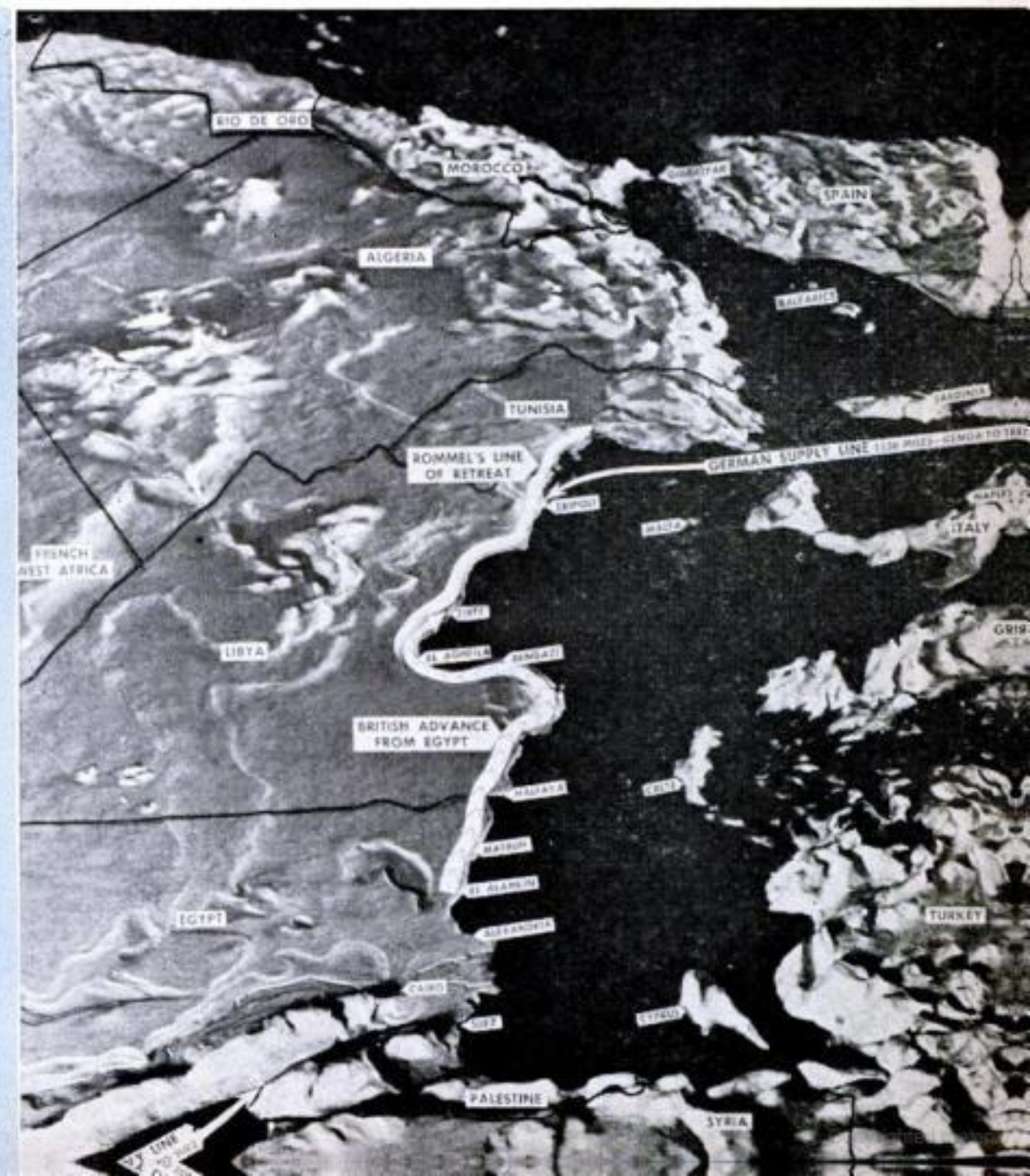
After 12 hours of cooling and hardening, the negative mold is carefully peeled off the master map. The glue has hardened into a flexible, rubbery mat with all the features of the original in reverse

The positive casting is made by pouring plaster into the matrix, which is placed face upward in a frame. After the plaster has hardened, the mass is turned over and the gelatin mold is stripped off the surface

In newspapers and magazines you have seen the sweep of armies and the strategy of global war made clear through relief maps in which oceans, mountains, and valleys stand out as if viewed by an observer on the moon. Pictures on these pages show how skilled sculptor-cartographers build these models that give you a ringside seat as history is made.

●

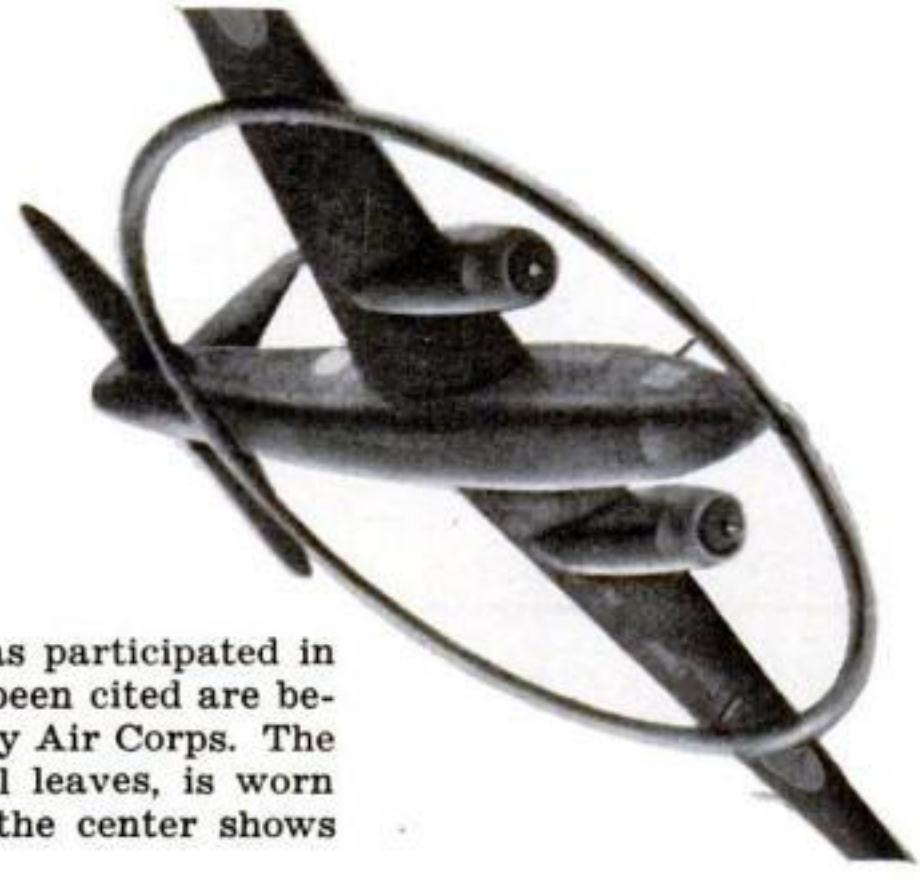
If the finished relief map is to be used for photographic reproduction, as at the right, seas and oceans are painted light blue, the rest left white. An artist-cartographer puts in such details as international borders, place names, and routes. An advantage of relief maps is that they can be photographed from any angle. This shows the Mediterranean war theater as viewed from the east



A DUAL TACHOMETER and synchroscope has been designed by the Kollsman Instrument Division of Square D Co., Elmhurst, N. Y., to aid in synchronizing the motors of a twin-engine plane. As shown below, the dial has two marked r.p.m. indicators. At the lower part of the dial is the synchroscope whose disk rotates to the right or left to indicate which engine is running faster. The pilot matches the pointers as closely as possible, and then makes a final adjustment from the synchroscope. When the latter is stationary, the motors are synchronized.

SAFETY HELMETS of transparent plastic are being made by the Celanese Celluloid Corp. to protect the hair of women factory workers from dirt and from being caught by the grasping "fingers" of whirling machinery. A snood protects the hair at the back of the head.

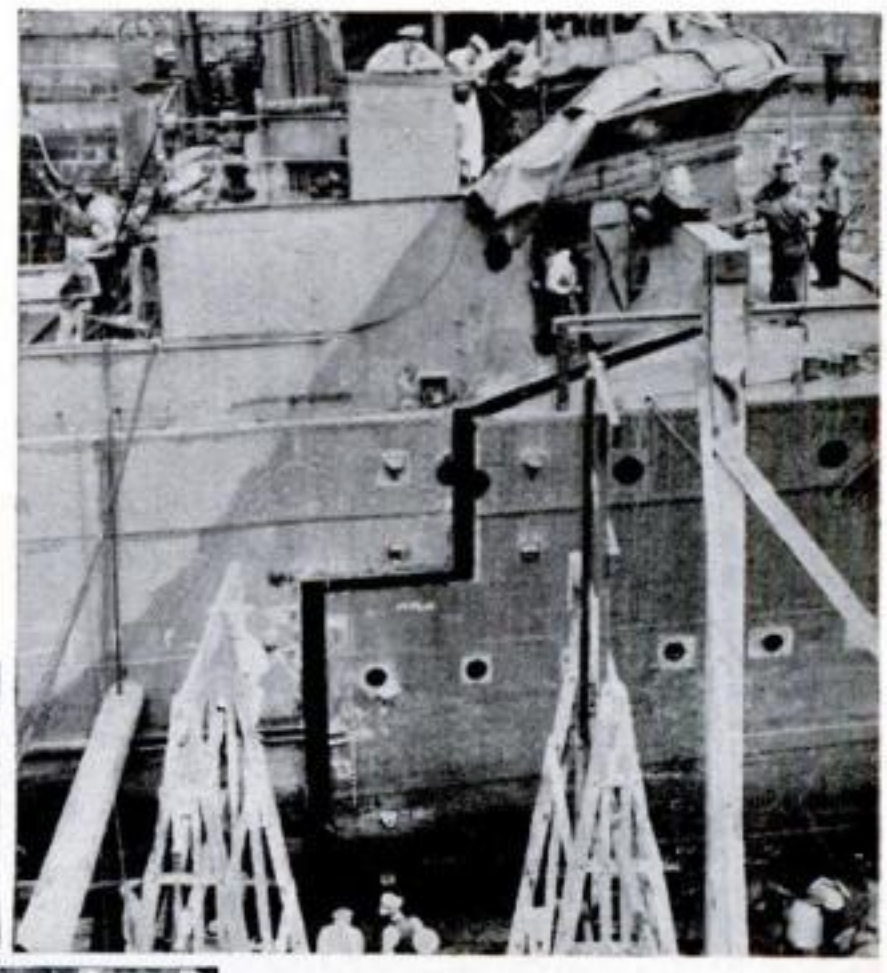
MAGNETIZED PLANES have been revealed as the means formerly used by the British to explode magnetic mines in the Thames estuary and Suez Canal. Wellington bombers equipped with a huge steel hoop encasing a live magnetic coil were used for the dangerous work, which required the planes to fly only 60 feet above the water. Ford V-8 auxiliary motors supplied current to the coils. The entire practice was finally abandoned when the degaussing gear was developed for the protection of shipping.



SPECIAL INSIGNIA showing that the wearer has participated in two or more actions for which his unit has been cited are being issued to individual members of the Army Air Corps. The insigne, a blue ribbon framed in gold laurel leaves, is worn on the left breast. An oak-leaf cluster in the center shows that the unit has received two citations.

NEW U. S. LIGHT TANK. Latest addition to the U. S. Army's growing tank family is the M-5 Light, seen at the right under test in California. Comparison with the photograph above will reveal several points of difference between the new tank and its predecessor, the M-3 Light. Instead of looking out through slits in ports when the tank is in action, the driver and machine-gunner use periscopes fitted with clamps to hold their heads in position. For ordinary driving, the periscope mountings are swung up and the men stick their heads out as shown. Turret and body of the M-5 are welded, whereas the M-3 has a bolted turret and a riveted body. The arrangement of the guns also has been changed.

DESTROYER TAKES A BOW. Like a piece being fitted into a jigsaw puzzle, the bow cut from the decommissioned destroyer *Taylor* is seen at the right being grafted onto the U.S.S. *Blakely,* her sister ship, at the Philadelphia Navy Yard. The *Blakely,* an old four-stacker, was badly damaged by an enemy torpedo last May. The new nose, plus other parts transferred from her sister ship by Navy workmen, have sent the hardy vessel back to sea as good as new—and, in fact, with more fire power and greater cruising range than she had before. She's ready for another brush with the Axis.



RELICS OF THE BLITZ compose a unique collection gathered in a basement museum by Richard Evans, of London. Shown at the left with some of his treasures, Evans has preserved coats-of-arms, statuettes, wall signs, and other relics salvaged from bomb-shattered buildings and streets. The collection will be kept as a permanent exhibit.

Look Out, Hitler—

LIBERATOR BOMBERS ROLLING OFF ASSEMBLY LINES SHOW HOW MASS PRODUCTION WILL SWAMP THE AXIS

By HICKMAN POWELL

Photos by Ford Motor Company

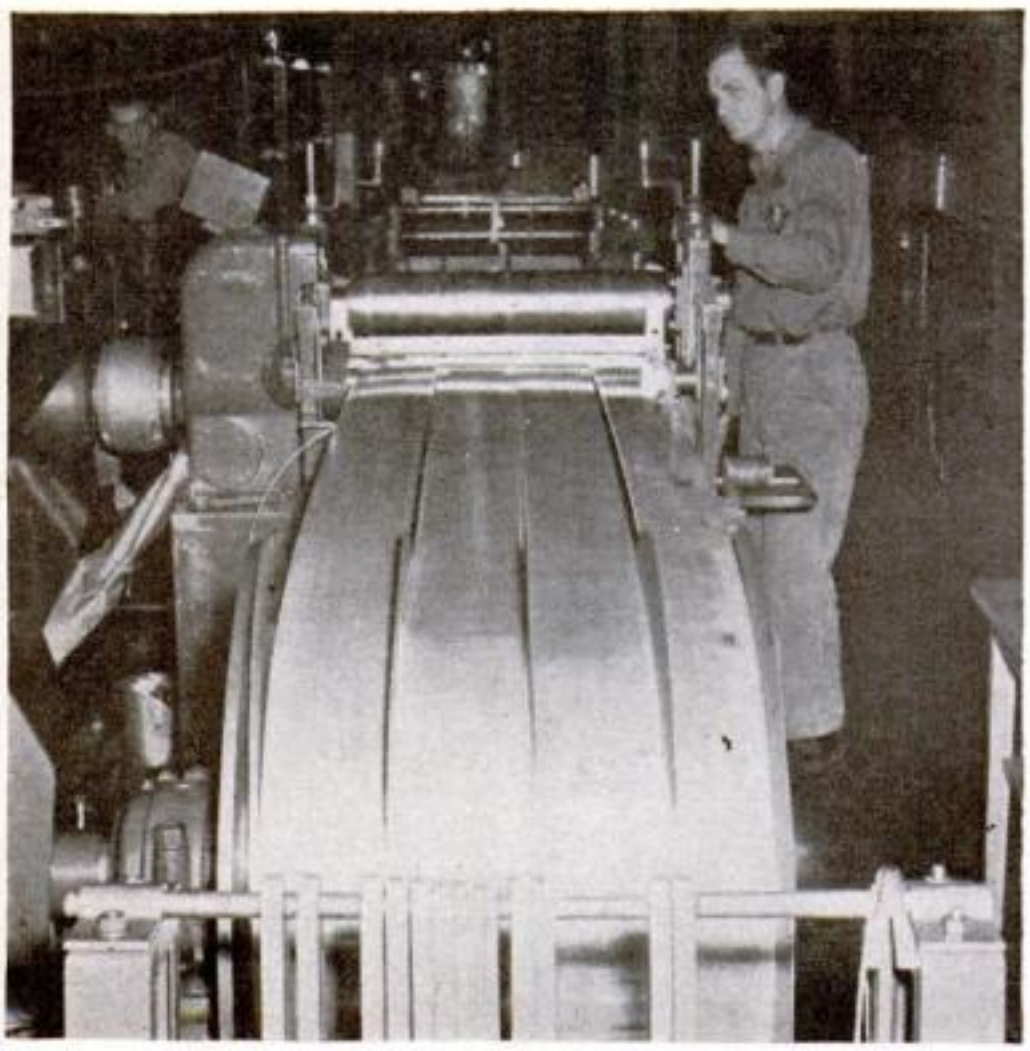
I HAVE just spent two days trying to absorb a quick glimpse of a fantastic future. My feet hurt from walking so far; my eyes ache from straining to see so many complex things; I feel somewhere between a state of brain fag and bewilderment, from trying simply to appreciate the immensity of an act of industrial imagination and faith so vast that it is beyond the possibility of quick human comprehension. I have been visiting the Willow Run bomber plant, created in the open country of Michigan by the Ford Motor Company and the Army Air Forces.

Willow Run is America's big all-out attempt to apply the technique of automobile mass production to the rapid manufacture of a four-engine bomber—the Liberator, the Consolidated B-24. Less than two years ago this vast site was a woodlot among the fields; most of its thousands of workers were untrained grocery clerks, farm hands, stenographers, and home girls. Today, after passing through all the preliminary acres of fabrication, you come to four long assembly-line conveyors, which eventually merge into two closely packed moving rows of bombing planes on the verge of completion. These are not just airplanes, mind you. The long-distance bomber is the most complex precision machine ever devised by man.

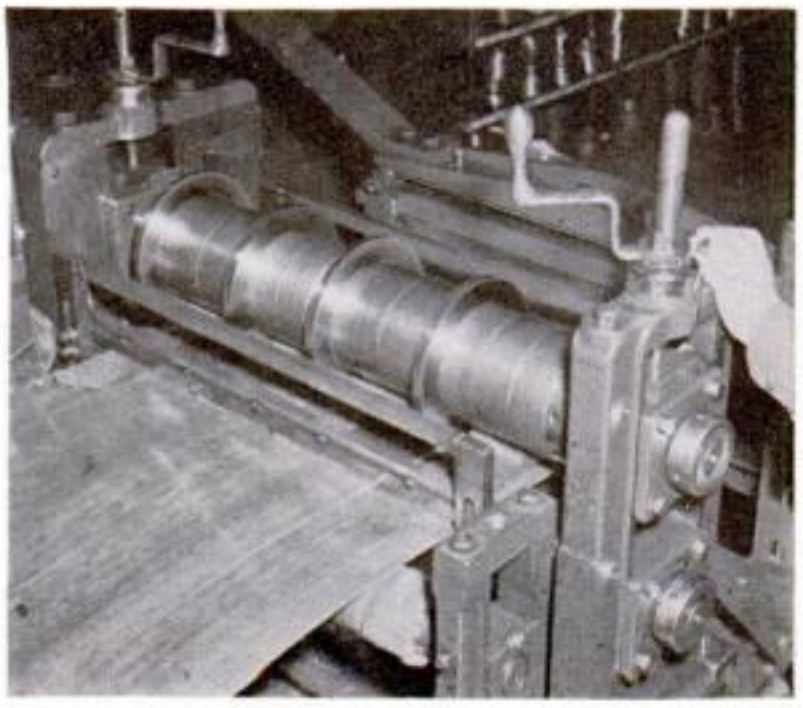
How often these assembly lines move—how frequently planes roll out to join their predecessors on the plant's great flying field—no one is permitted to say. In any case, a figure that is true today would be false a month from now. But it is possible to say that Willow Run is running. The river is rising. Mr. Hitler, here comes the flood!

Those thousand-plane bombing raids over Germany were mere dress rehearsals. All the books and articles and talk about air power and bombing the Axis to its knees—they were mere advance scriptwriting for this mechanical drama which now begins to move. Mystery and secrecy and rumors have surrounded it. There were whispers from those who said it couldn't be done, and from those who said it should have been done faster. True, there have been monumental difficulties and delays. After all, Rome was not built in a day. But now that

SHEET METAL IS CUT INTO STRIPS, SHAPED BY MACHINE



1 Production starts with small rivulets of materials entering at one end of the mammoth plant. At the left, aluminum alclad strips coming from a Yoder slitting machine are wound up on rolls for easy handling. In the machine, the knives shown below are spaced to cut the metal into strips for stringers with a minimum of waste

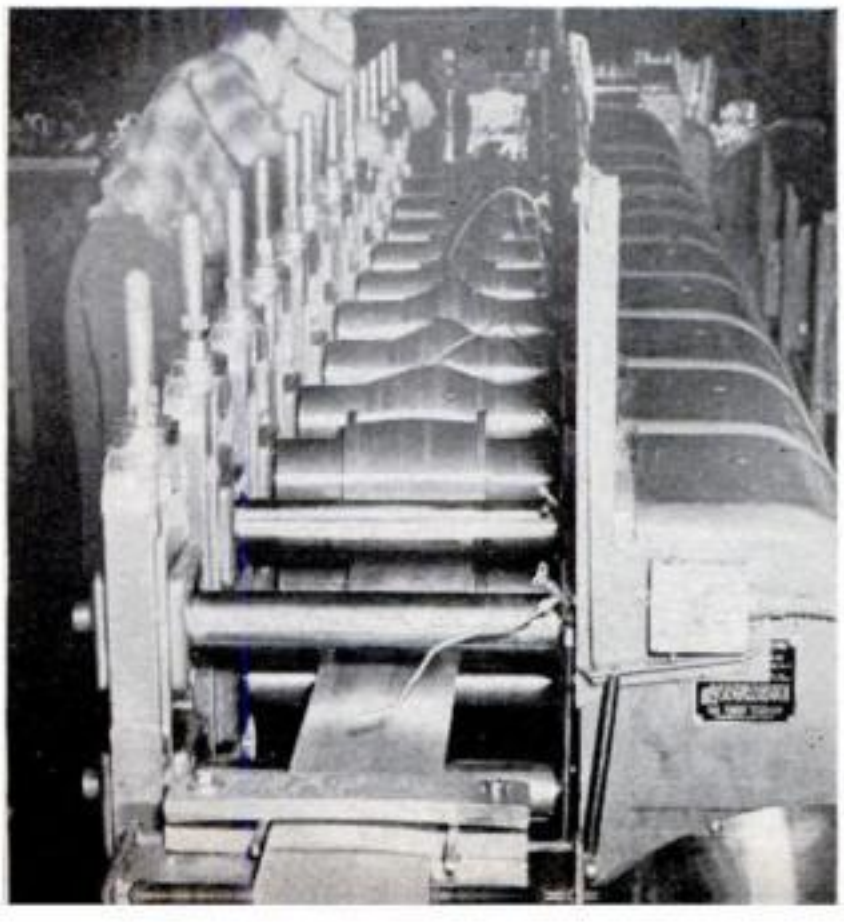


HERE COMES THE FLOOD!

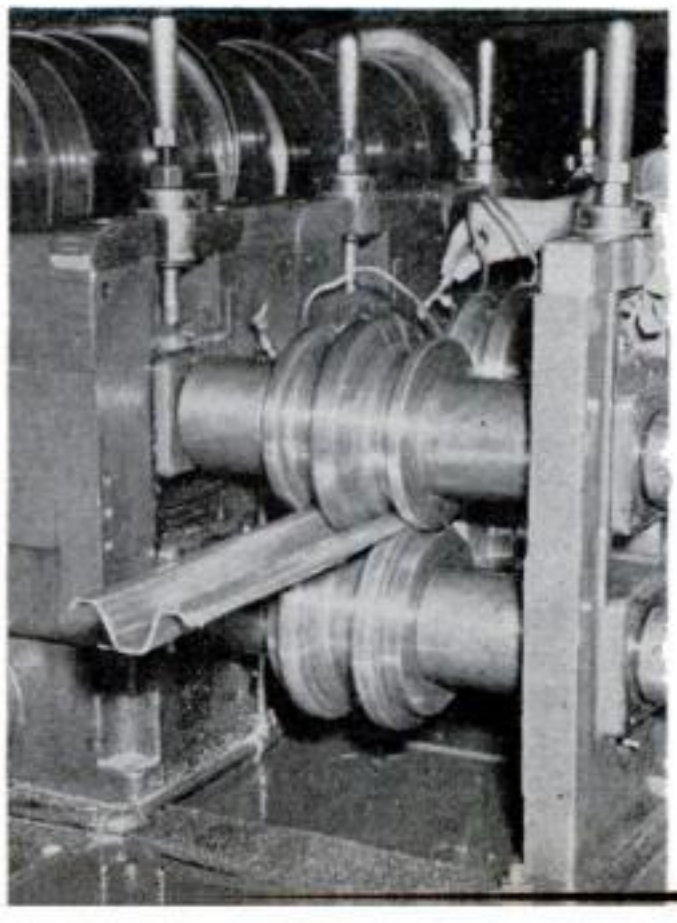
Consolidated B-24 Liberator bombers nearing the end of one of the two final assembly lines at the Ford Motor Company's gigantic Willow Run plant. Note that the ships farthest back in the line have not yet received their outer wing sections. Each time the line moves, the staging slides back sufficiently to clear the landing wheels and the planes are drawn forward by a cable under the floor, moving up one station

AND COMES OUT AS STRINGERS FOR THE BOMBER'S WINGS

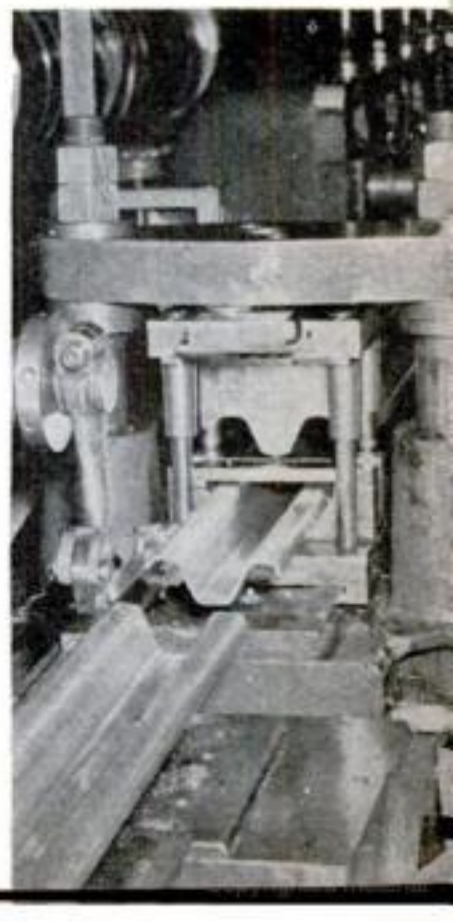
2 From rolls the strips are fed into the Yoder machine in which a series of progressively rounded rollers presses them into hat-shaped stringer sections. The little tubes bent over the strips carry oil which drips onto the metal to protect it from marring as it is rolled into shape. Alclad is duralumin with a pure aluminum coat to bar corrosion



3 Here the stringer section has assumed its final hatlike shape. A workman's hand can be seen adjusting the flow of oil. Protection against marring is important, as any scratch cutting through the pure aluminum coating on the duralumin will ruin the part by exposing it to corrosion



4 From the Yoder machine the stringer sections pass through a cutter in which a blade with the same hatlike shape cuts them to size without distorting their characteristic formation



the curtain lifts a little, it is possible to assure Mussolini that Rome *could* be destroyed in a few hours.

While Hitler's divisions drove through France, less than three years ago, President Roosevelt called for an increase of airplane production capacity to 50,000 planes a year. Practically everyone thought he was talking big, taking a random shot at the moon. Airplane building was then little beyond the handicraft stage, for the simple reason that big orders for big planes had been practically nonexistent. But then the aircraft industry proceeded to work miracles; and today the President's audacious production aim is a reality, almost a commonplace. The aircraft industry accomplished this by speeding up the natural development of its already tested methods of production.

To this miracle Willow Run contributed very little. This plant is something extra, added on top of all the rest. It is an attempt, starting from scratch, to encompass the natural industrial evolution of 20 years all in one big gulp. In place of the airplane craftsman's method of cut, bend, and fit—by which fighting planes are still produced—it seeks to sweep in the principle of interchangeable parts.

Willow Run has been making "parts" for a long time. This does not sound very impressive, until you discover that in Willow Run language a "part" may be something no more simple than a center wing section, 60 feet across—the structural element on which are assembled the four engines, the fuselage, the landing gear, and a complex infinity of hydraulic and electrical controls.

Counting 700,000 rivets, there are 1,250,000 separate parts in a B-24. You enter the plant at the manufacturing end, where the raw sheet duralumin comes in and is cut, stamped, and molded into these integral units. As you move on, into the great acreage devoted to subassemblies, the parts become more complex. For each part there is a jig or fixture (the terms seem to be used somewhat interchangeably, though most of the Willow Run installations are properly fixtures) into which the original parts are fitted and assembled into a precise pattern. No matter how big or complex, a "part" thus made will mate precisely with its adjoining parts, on the assembly line.

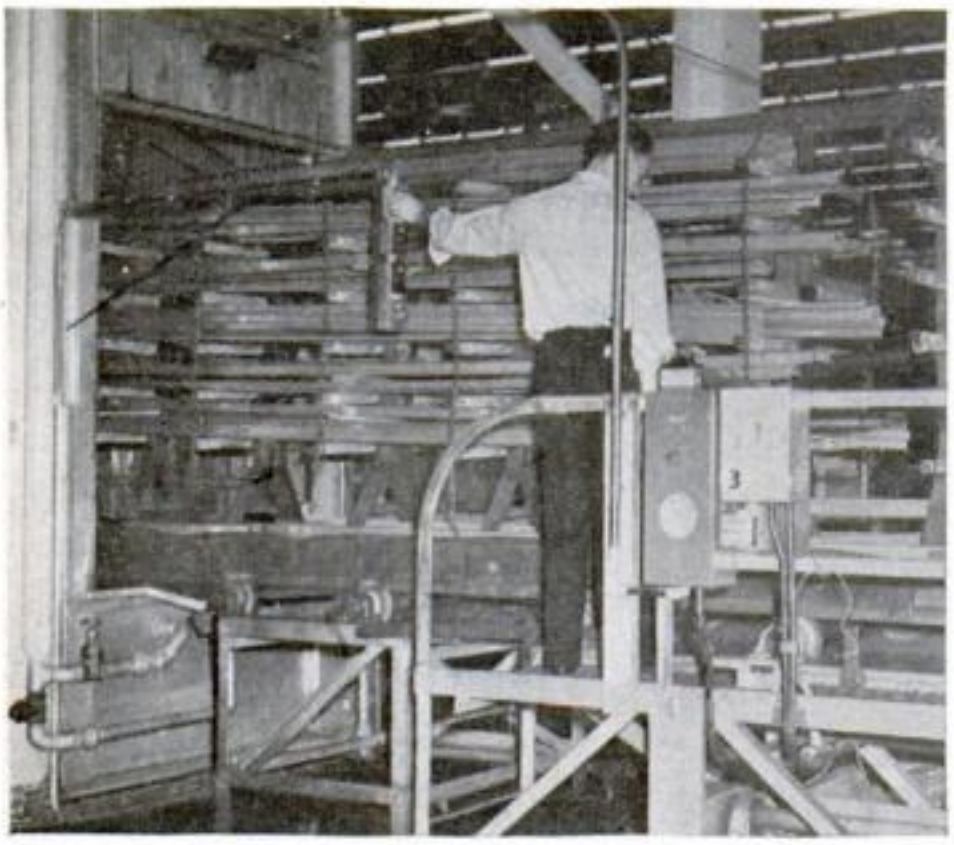
Far down the plant, the final assembly begins to take shape. The 60-foot center wing section, in crude form, is placed in a conveyor system, suspended by its ends. There is not just one of these conveyors; there are four of them side by side, each carrying a row of center wing sections on from station to station, gaining additional complexity at each stop. At one such station, for instance, the wing section encounters an Ingersoll milling machine which simultaneously carries out on it 26 different machining operations—doing in less than an hour a complex lot of metalworking which formerly took days. That is what happens at just one station.

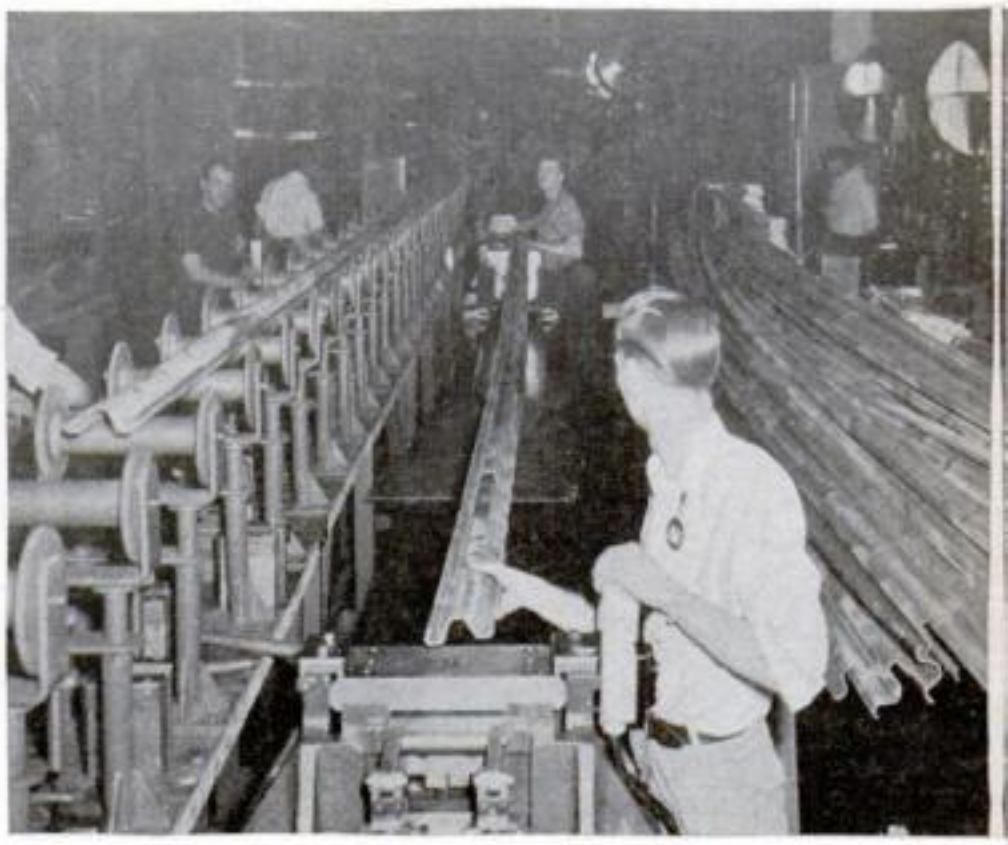
At last, after the wing section has ac-

STRINGERS ARE HEAT-TREATED, STRETCHED, STRAIGHTENED

5 Long stringer sections are loaded onto a large rack which is rolled into a heat-treating furnace. After this treatment the rack moves into a quencher where cold water twists and curls the hot stringers as seen below

6 Stretching the stringer 3½% in this machine removes the kinks and also strengthens the metal by changing its molecular structure. The rollers at the left carry it to another station





quired its landing wheels, the four conveyor lines are drawn together into two final assembly lines pulled by underground cables. This makes room for the planes to take on their outer wing sections and attain their full spread of 110 feet.

Elements of mass production have been introduced in all military-airplane plants. At Willow Run, planned originally for mass production, the Ford organization has introduced speed-up changes which fall into four main categories. They can best be made clear by taking them up one at a time.

1. The use of great, heavy presses with hard steel dies, such as are used for stamping out automobile bodies, for drawing, bending, cutting, and forming various duralumin parts.

The big Ford presses stamp out parts like so many biscuits, but it required great ingenuity to make this possible. Special steels had been developed for automobile stamping, and the special properties of airplane metal were quite different. Its cold flow is such that it tends to wrinkle and fold; dies had to be devised to allow for this. There were those who thought it impossible, but it has been done.

Outstanding in the press work are the complicated frameworks for such parts as the pilot's and bombardier's transparent enclosures. A single stamping in one case now forms a piece formerly made with 33 parts. This was accomplished by using a softer, thicker grade of metal, which would draw better. The extra weight was counterbalanced by elimination of rivets and overlapping joints.

2. Better tooling than the airplane industry ever before could afford. In small aviation contracting the tooling cost was always the most dangerous item. At Willow Run no expense was spared to get the best tool for each operation; and the jigs and fixtures are more accessible and more heavily constructed than ever before. For assembling stringers, for instance, it had been customary to use loftboards—great tables bearing full-scale drawings, which made workmen dependent on ink or pencil marks for their dimensions. At Willow Run every such operation has its own steel bench or framework, with dimensions unalterably and precisely fixed in tool steel.

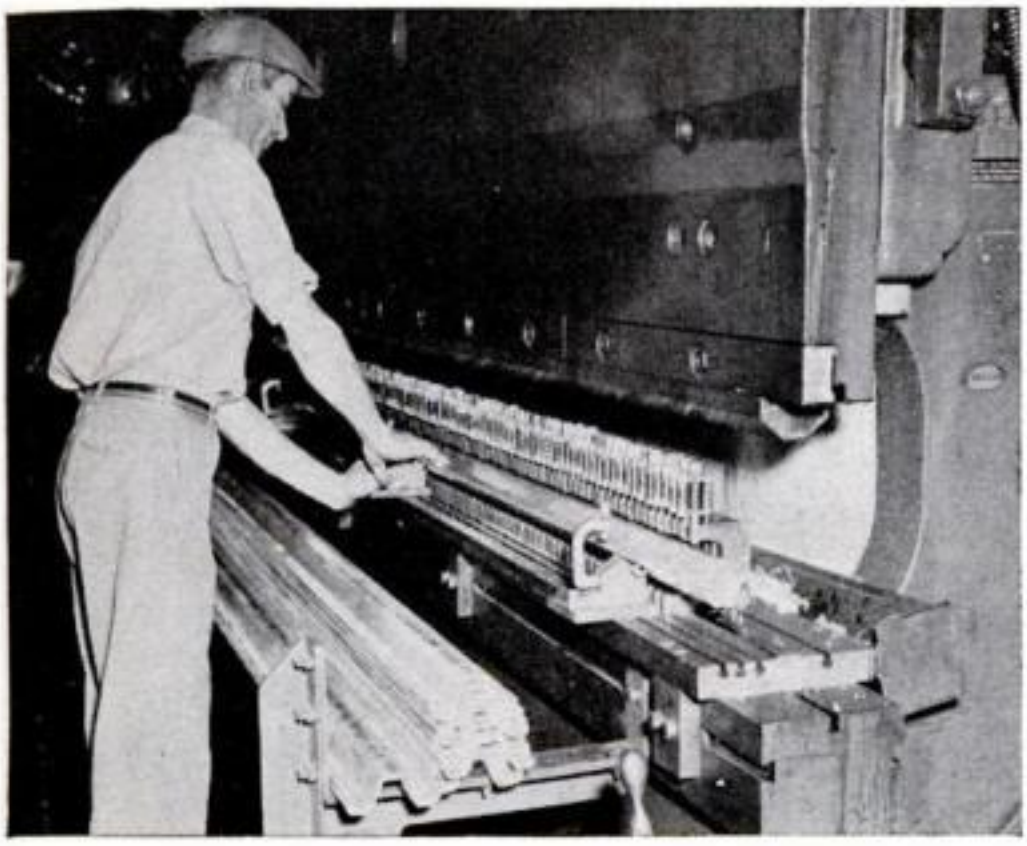
3. The plane is broken down into smaller parts for subassembly than ever before. The jigs and fixtures are so constructed that detailed installations can be made long before the final assembly line has been reached.

When an airplane fuselage is built as a unit, for instance, its interior is a very crowded place in which to work. In the forward section of a fuselage, a half dozen workers would find themselves crowded and interfering with each other. But when that section is constructed as four separate panels—top, bottom, right, and left, then two dozen men can work on the interiors of these panels simultaneously with plenty of room.

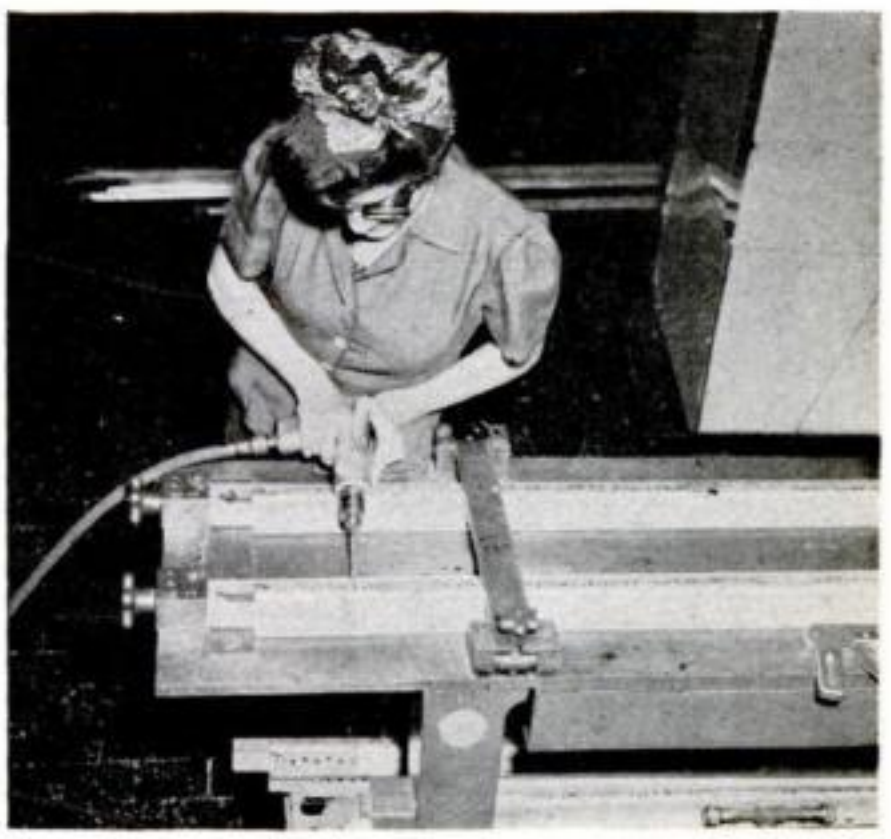
4. The final big *(Continued on page 202)*

PUNCHED WITH DRILL CENTERS, MADE READY TO INSTALL

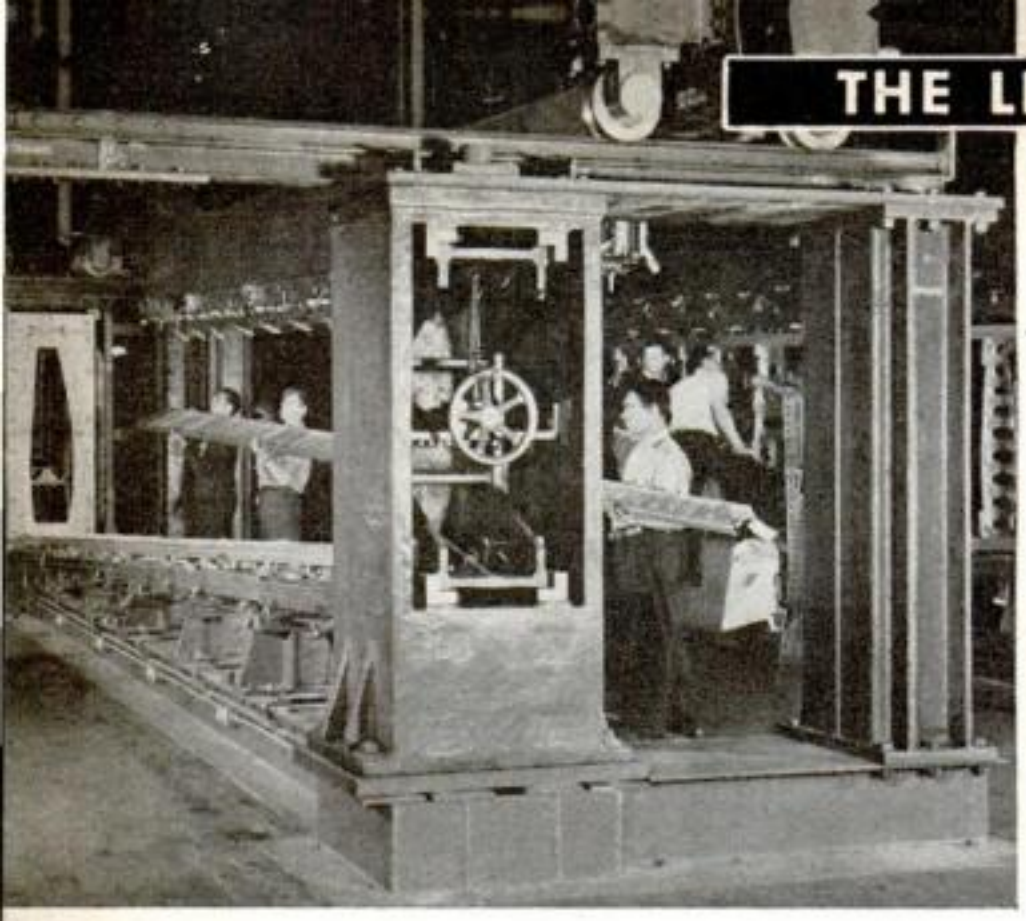
7 Stamped for identification of its particular use, the stringer is placed under a huge punch press which pierces it with a precise pattern of small holes to guide in drilling holes for rivets



8 At the stringer assembly bench, a woman worker drills holes in the end of the stringer section preparatory to attaching it to a forging. The assembly bench replaces loftboards (CONTINUED)



THE LIBERATOR'S WINGS TAKE SHAPE



9 In this massive fixture, specially developed for the Willow Run plant, an outer wing section will take shape. With the top rolled back, workmen are placing the forward spar in position

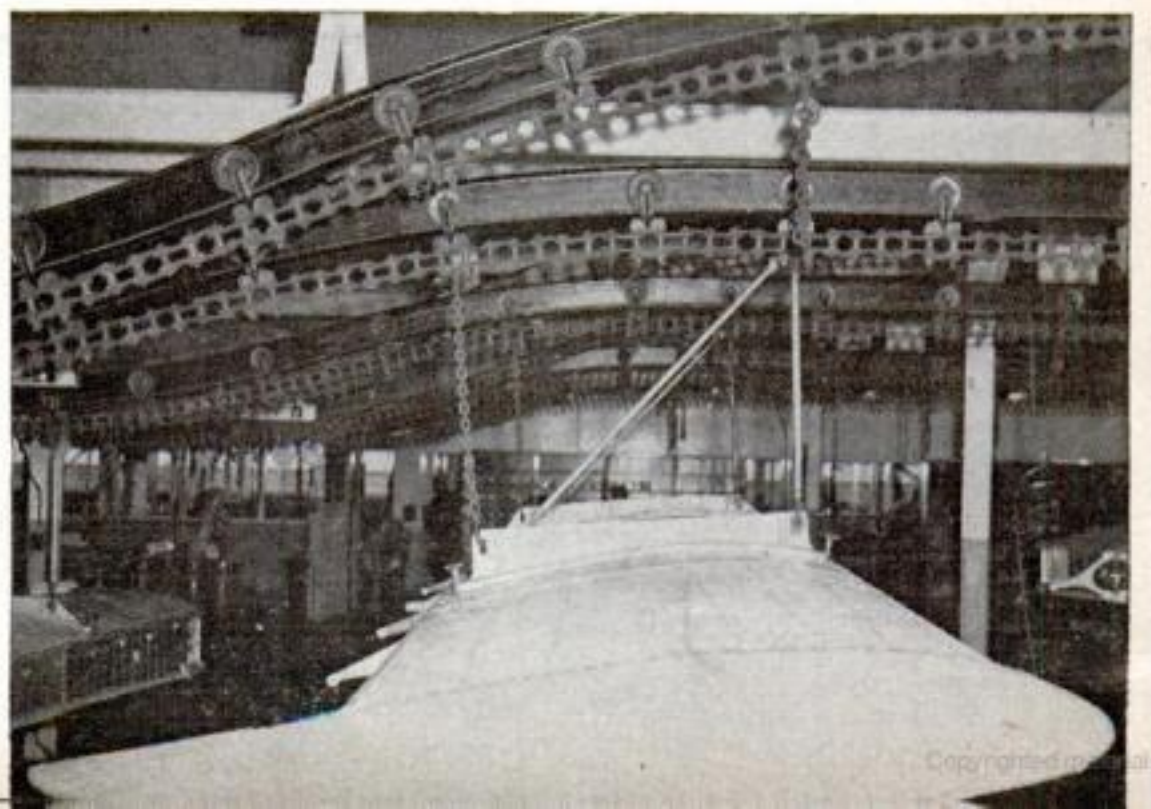
10 Here the spars and bulkheads are in place in the fixture. The wing section is assembled in a vertical position, with spars laid horizontally at top and bottom and bulkheads set between them

13 This close-up shows two workmen riveting the skin through holes drilled to line up with the stringers, which are on the other side of the skin. This is the lower wing surface

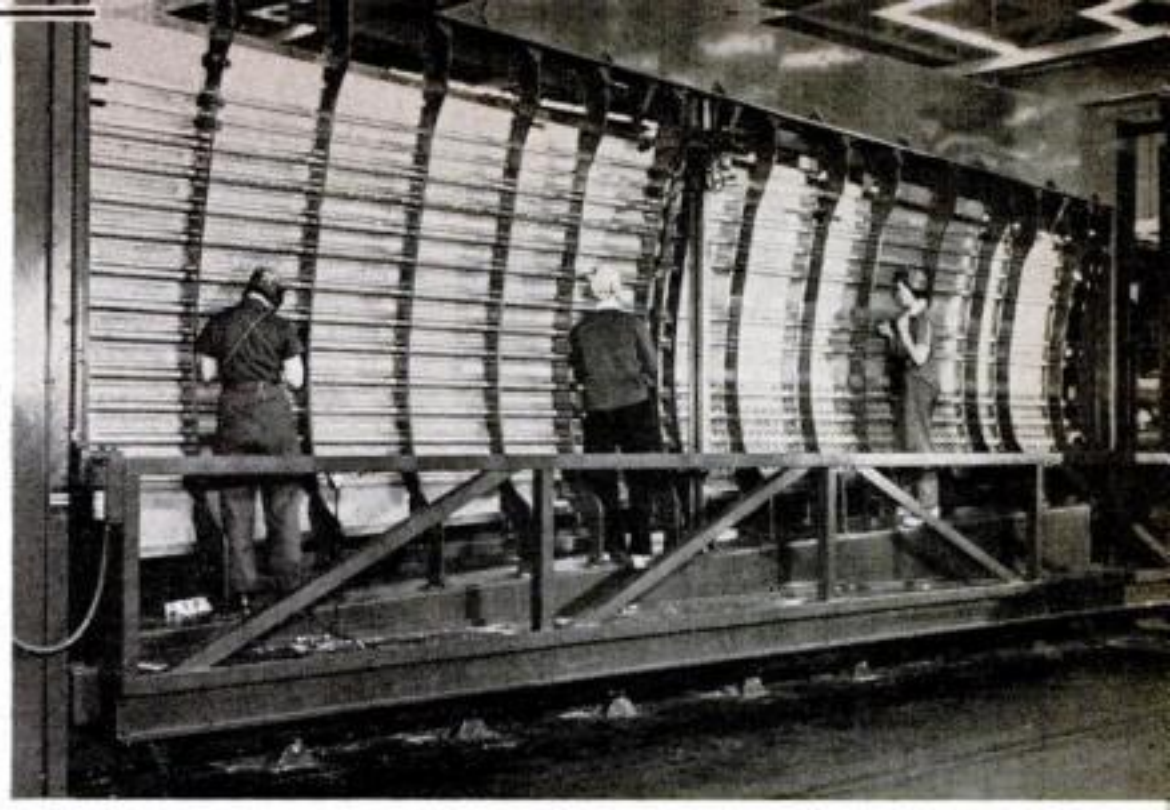
14 When the skin and stringers have been assembled, they are moved to the bulkhead fixture for attachment to the wing. The lower skin, which is put on last, has holes in it through which riveters can work. Women are widely employed at Willow Run, and eventually will compose 25 percent of the plant force

17 At one of the stations, a man and a woman lift the wing tip into position. The leading edge has not yet been attached (note spar visible at left of man's elbow)

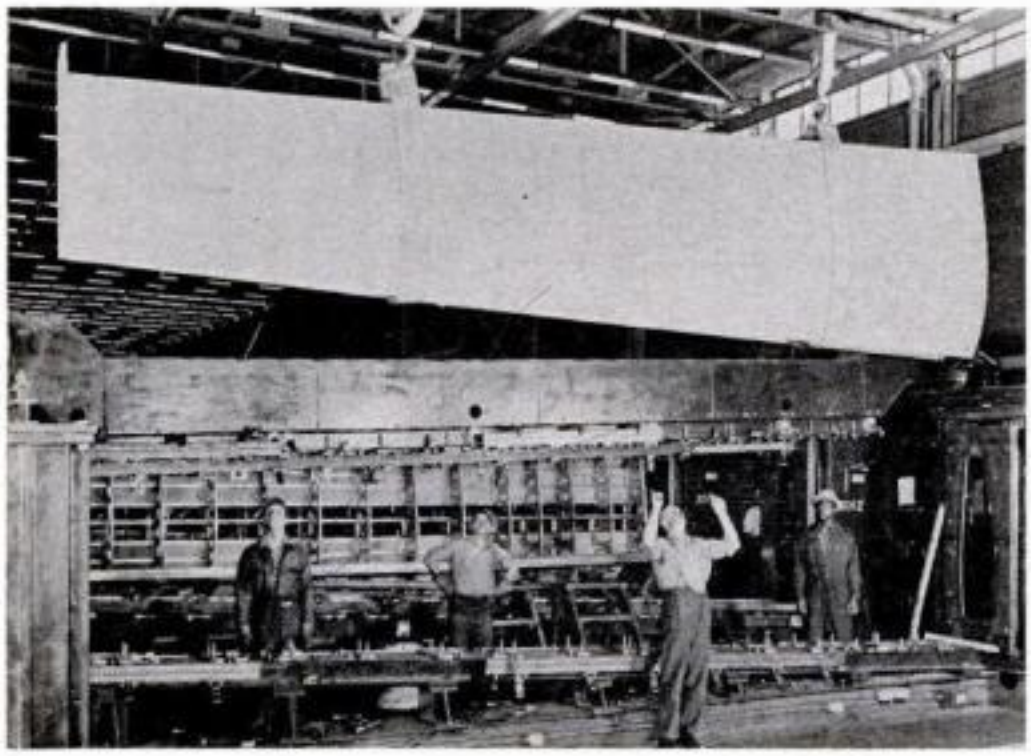
18 Now the wing section is picked up by an overhead conveyor and soars through the plant toward the final assembly line. It already has a finished look, although the leading edge and aileron still remain to be attached



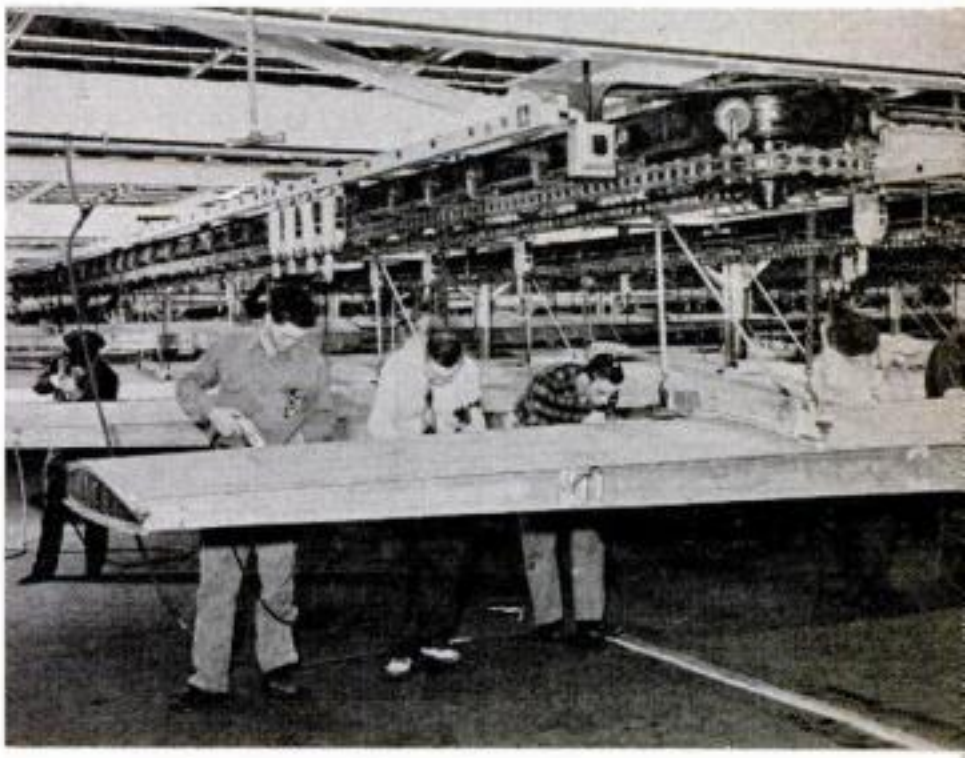
11 In another fixture, stringers are put in position for attaching to the wing skin. The stringers have been assembled so that they are lighter toward wing end (right)



12 Now the metal skin is riveted to the stringers. The curved uprights on which stringers are held simulate the contours of the surface. Riveters stand on an elevator platform which raises them for work on the higher levels



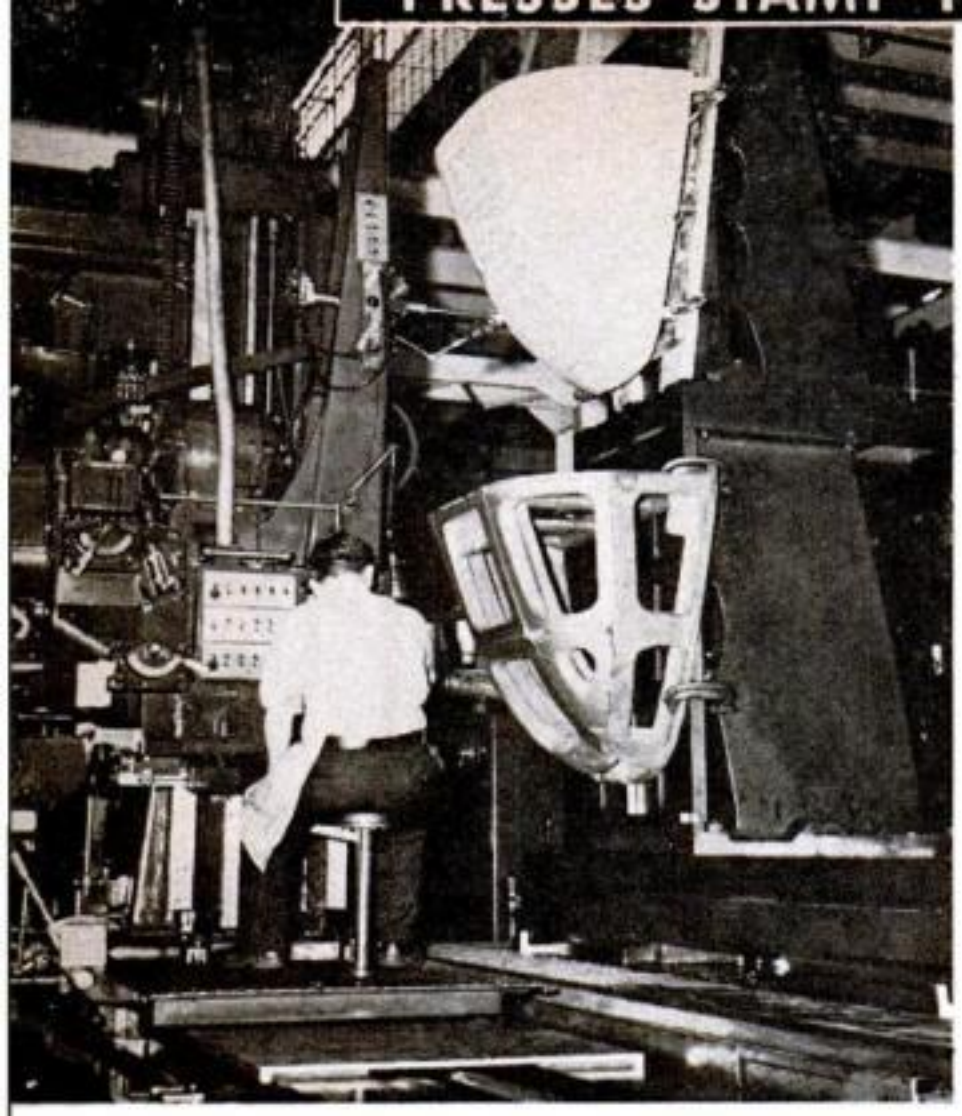
15 Now the wing section is completed. The upper bridge of the fixture is rolled aside and an overhead crane lifts the wing panel out and carries it to a conveyor system. As soon as it is out of the fixture, the upper bridge is replaced and work begun on a new section



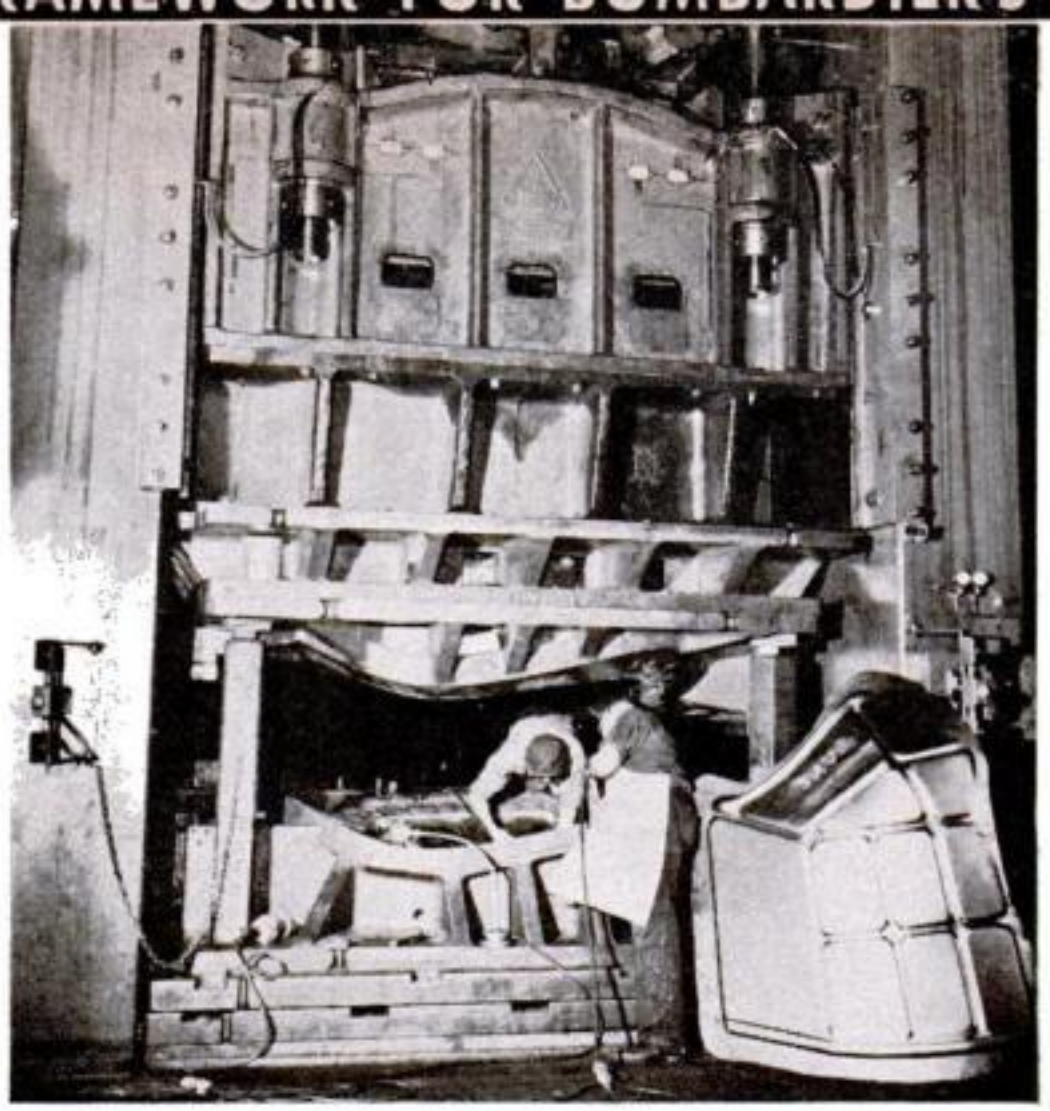
16 In the meanwhile, the wing section has been placed on a horizontal conveyor system which carries it from station to station where it receives its furnishings, including the wing tip, aileron, and the leading edge

19 Here three workers, two of them women, are seen lifting an aileron into place. This step takes place after the outer wing section has been attached to the center section. Aileron is rigged for operation by pilot

20 The leading edge of the wing goes on. A rubber de-icing mechanism is built into this edge as a protection against the formation of ice at high altitudes (CONTINUED)

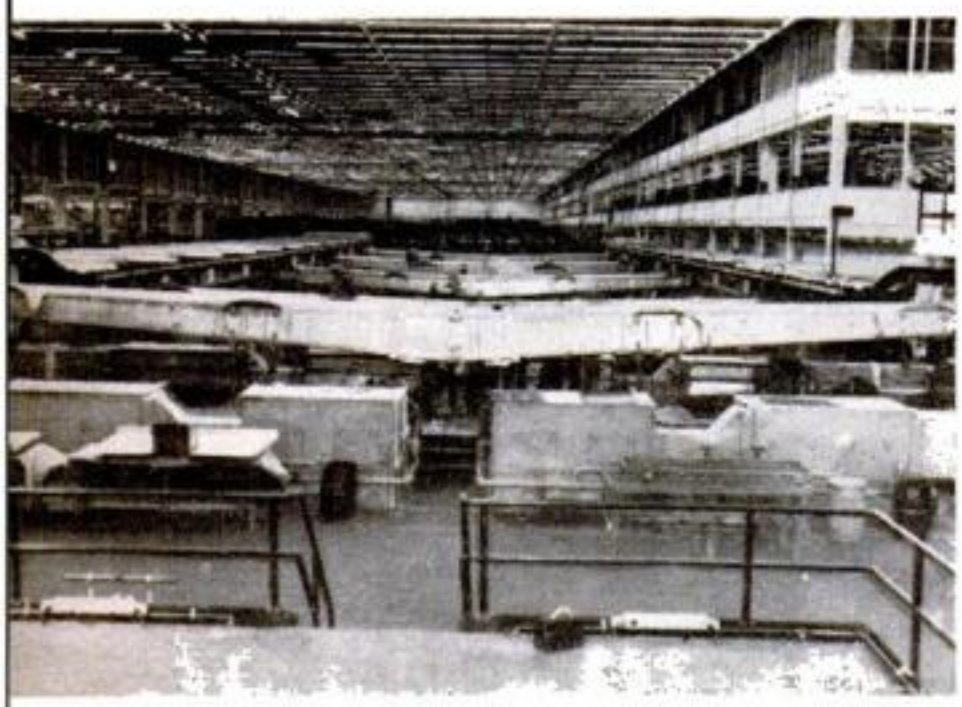


21 In the meanwhile, other parts are coming into the main stream. Here a profiling machine traces a pattern and cuts a die for drawing out part of the bombardier's enclosure

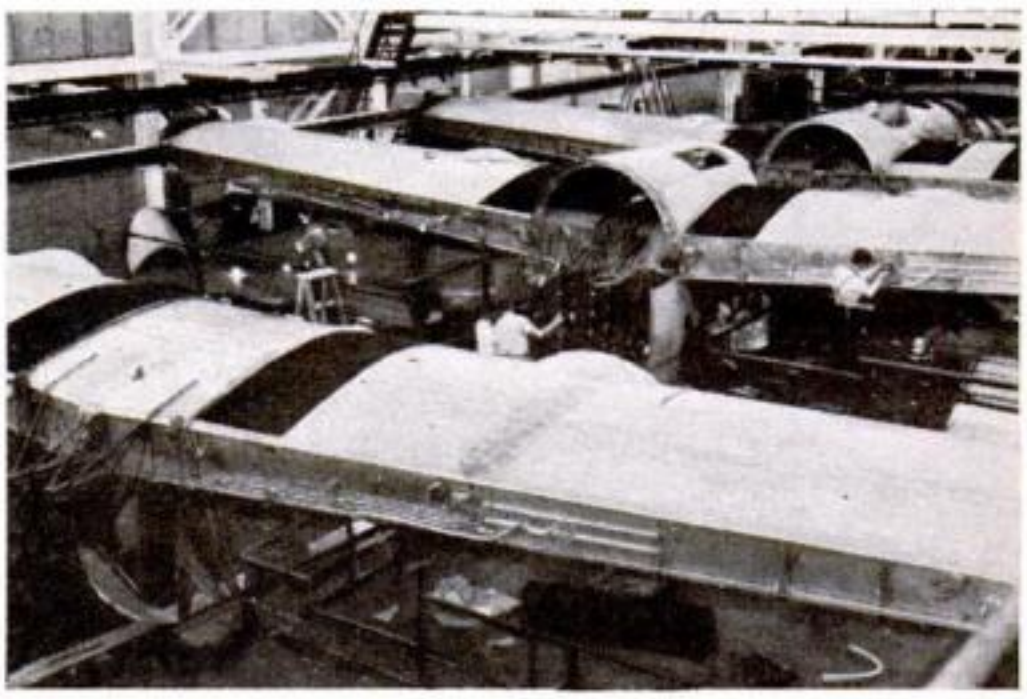


22 An innovation at Willow Run is the use of powerful presses, such as are employed in the automobile industry, for aircraft manufacture. Four 1,000-ton hydraulics like this draw out parts for enclosures and fairings

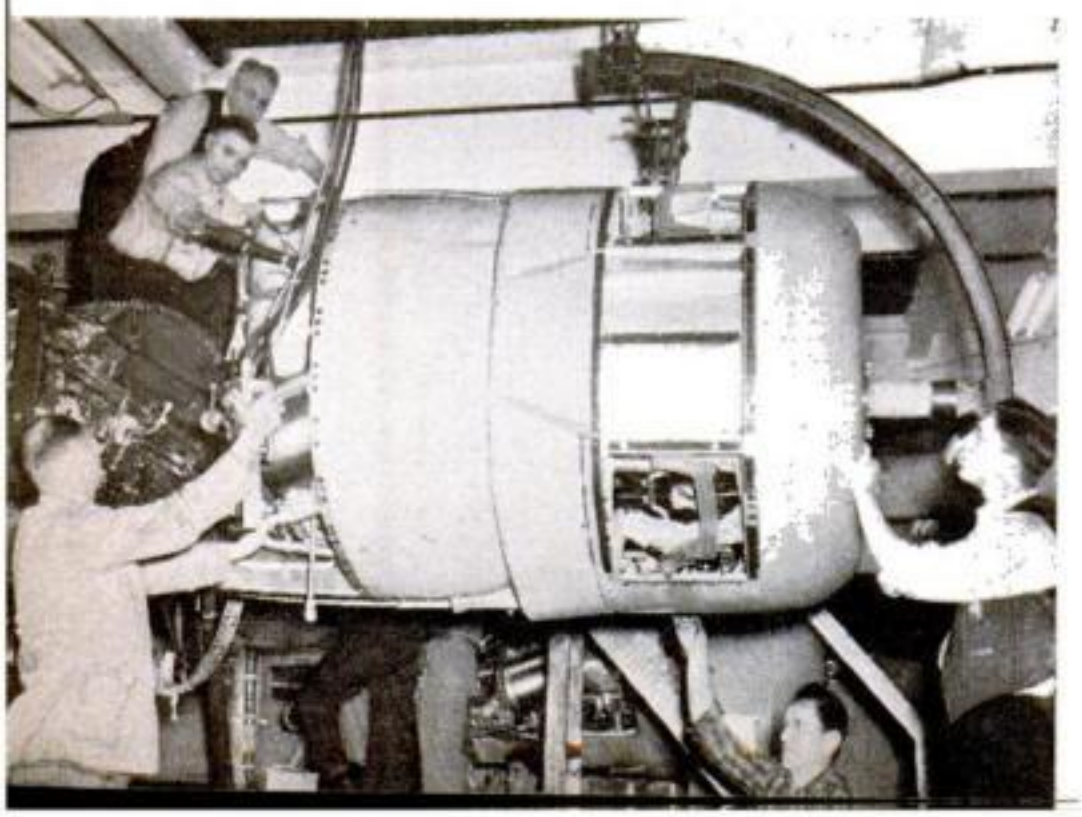
CENTER WING SECTIONS GRADUALLY BLOSSOM INTO PLANES



25 Center wing sections, 60 feet wide, start down the final assembly. There are four parallel lines like this, on which other parts from the subassemblies are gradually added



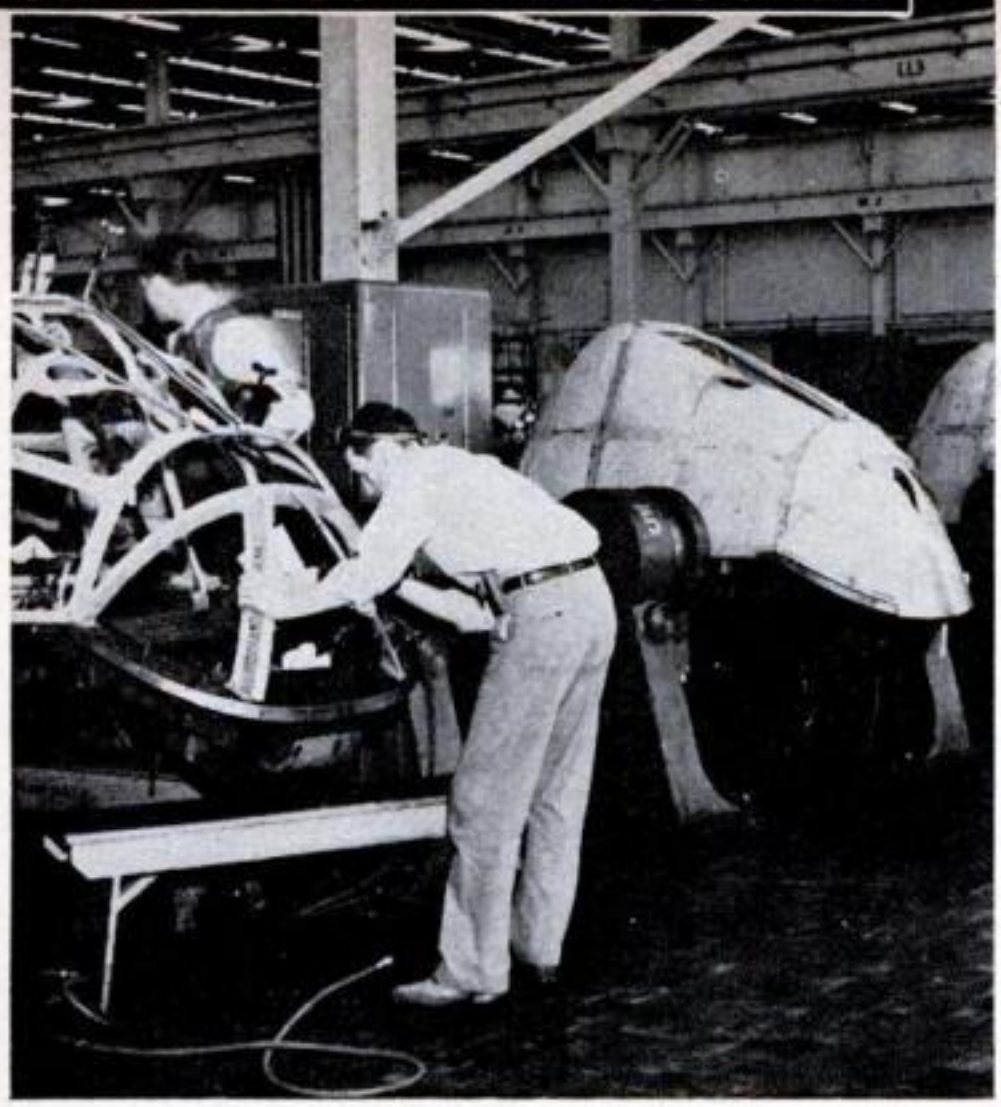
26 Now the Liberator really starts to take form. At the first mating station, bulkheads, longeron bomb racks, and side panels are installed. At the second, the nose is attached to the center wing. The stream flows on



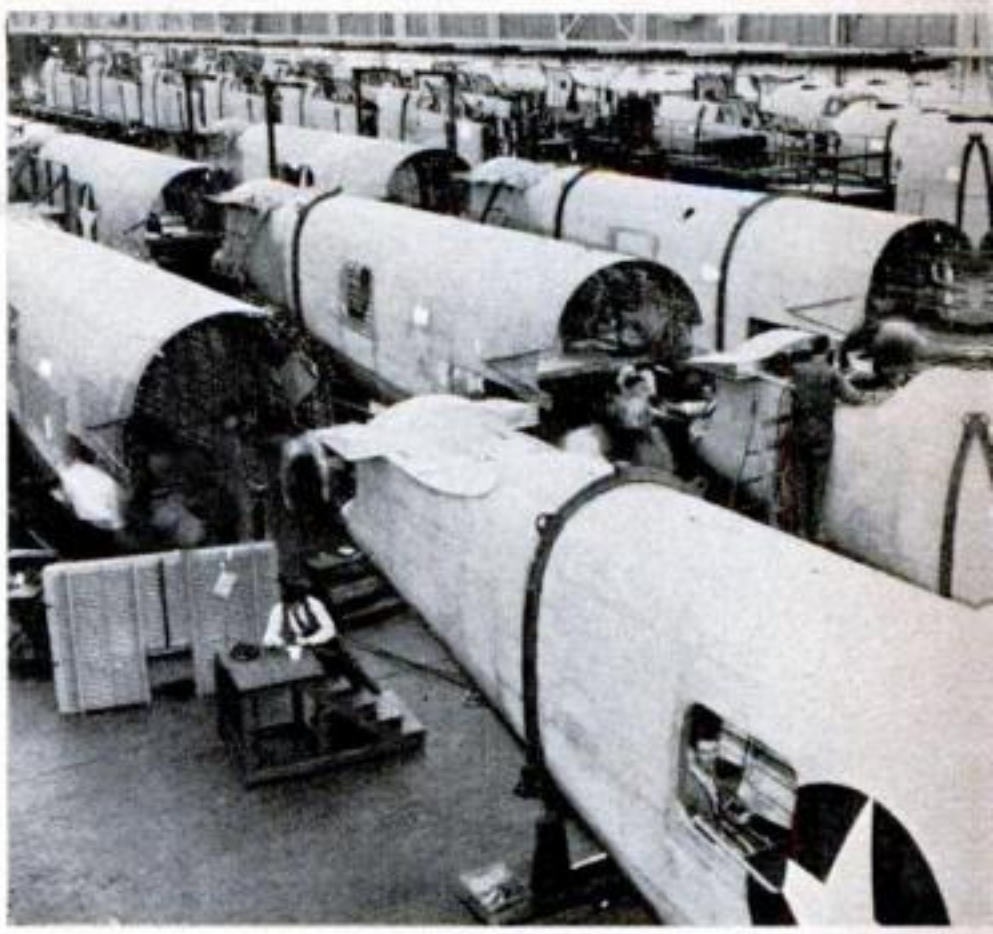
27 Down through a hole in the ceiling comes one of the four huge 1,250-horsepower Pratt & Whitney engines ready for installation

28 Next the outer wing sections move in and are attached. Made on separate fixtures, they mate perfectly. Note man inside center wing

AND PILOT'S ENCLOSURES



FUSELAGE SECTIONS ARE JOINED AND PASS ON TO ASSEMBLY LINE

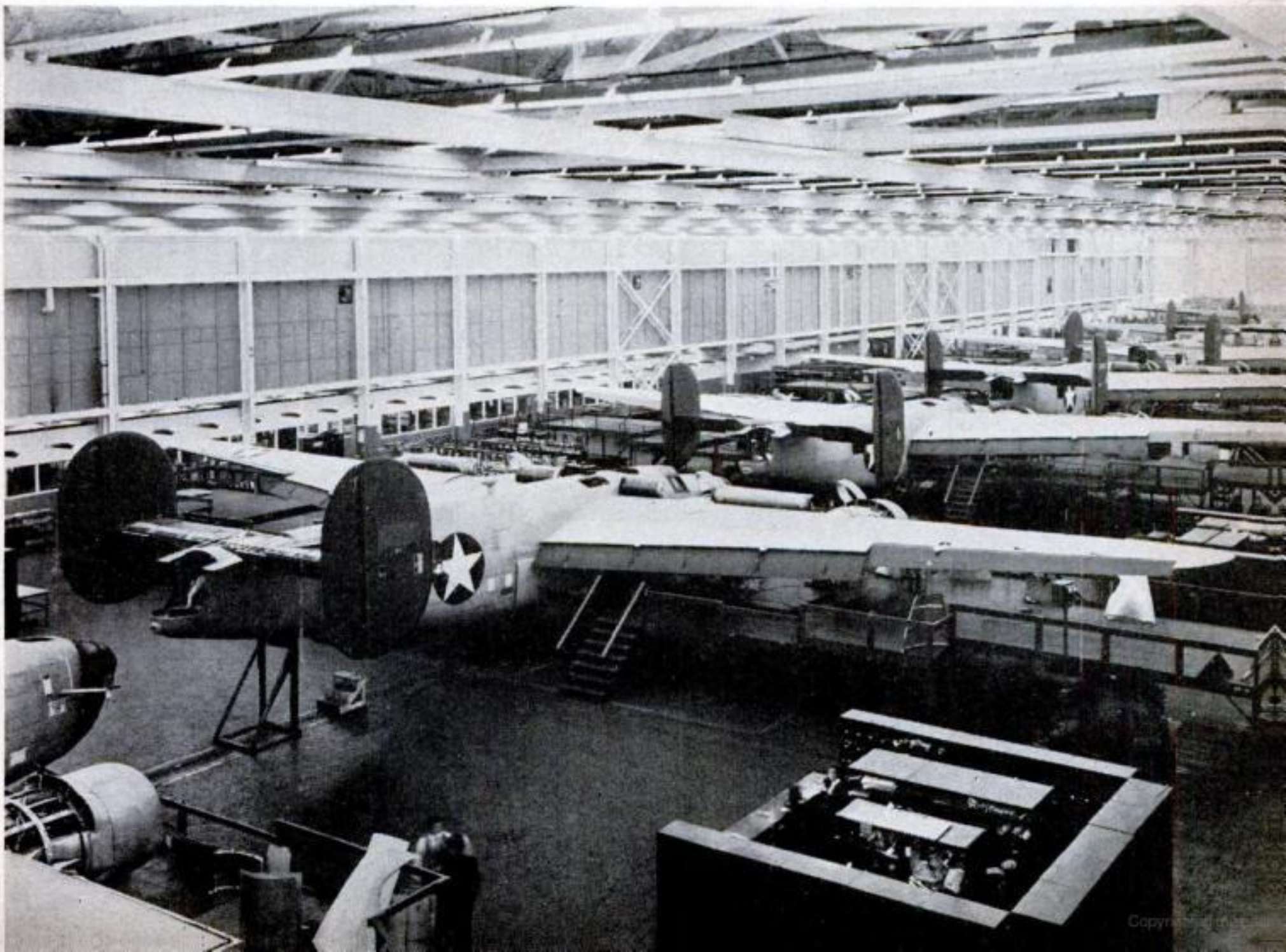


23 Ingenious fixtures designed by company engineers provide steady, precise bases on which bombardiers' compartments and similar parts are assembled and prepared for installation in planes

24 Fuselages, each assembled from a dozen parts, take shape in another part of the plant. In the foreground are the aft fuselage sections receiving finishing touches; at rear, forward sections

AS ASSEMBLY LINES POUR LIBERATORS AGAINST THE AXIS

29 Like an inexorable flood, the line moves on. All the rivulets of materials and labor in the mammoth plant find their way to these final assembly lines, just as countless tributaries feed a mighty river. This line is a symbol of the rising torrent under which the Axis will soon be engulfed



SHE ISN'T MUCH TO LOOK AT— BUT THEY CALL HER

Ten .50 caliber machine guns protect the Liberator as she wings toward an enemy target. "A four-engined fighter" is what some call this bomber

OUR CONSOLIDATED B-24 BOMBER CARRIES A PROMISE OF DELIVERANCE TO THE WORLD

By ANDREW R. BOONE

WHEN Winston Churchill flew from England to French Morocco for his historic meeting with President Roosevelt at Casablanca, he used a Consolidated Liberator—the same plane, with the same American pilot, which had carried him to Moscow for his conference with Stalin. The fact is significant, for this long-range, high-altitude precision bomber has come to mean just what its name implies—a symbol of liberation for the oppressed peoples of Europe and of all other parts of the world where the Axis has set its heel.

Who gave the Army's B-24 her name may never be known. Two years ago, Major Reuben Fleet, then president of Consolidated Aircraft Corporation, wrote the Navy Department saying that here was a ship that would liberate the world from tyranny. Some time later, an unidentified Britisher dubbed her "Miss Liberator."

No one, not even her makers at the Consolidated plant in California, where she was born, is proud of her appearance. She looks fat and awkward indeed, and sits squat on an airfield, with husky .50 caliber machine guns sticking like pinfeathers from her nose, belly, back, sides, and tail. But don't let her seeming clumsiness fool you. She's one of the deadliest and most devastating weapons ever created by the hand of man; with that quality her builders—and, more important, the men who fly her—are tremendously satisfied, for she carries a heavier bomb load than any other ship of her class.

Sitting on a field, the Liberator bids for confidence. You can't see all the features that make her a much-feared aerial battleship. She rests on three wheels as the engines bark into action, when she rolls away with a throaty roar for a 120-m.p.h. take-off. Turbo-superchargers help carry her to great heights, and with two engines shot away she can maneuver normally. She's more heavily armed than the Flying Fortress, America's first gift to precision daylight bombing.

The Liberator is as truly tailor-made as the finest suit in your wardrobe. She rolls off the Consolidated assembly lines ready to fly. But she can't go to the pilots in Libya or the Aleutians or the Solomons until her engineer-tailors have fitted her for the precise job and conditions she will face.

If she's bound for cold country, shutters must be installed on the oil radiators, spe-

FACTS About the LIBERATOR

Heaviest, and one of the fastest, of American bombers.

Known to the Army as the B-24, to the Navy as PB4Y.

Present models armed with 10 .50 caliber machine guns.

Carries a crew of five to eight, more than four tons of bombs.

Service ceiling 19,000 feet, but is said to have bombed the Japs from 35,000 feet.

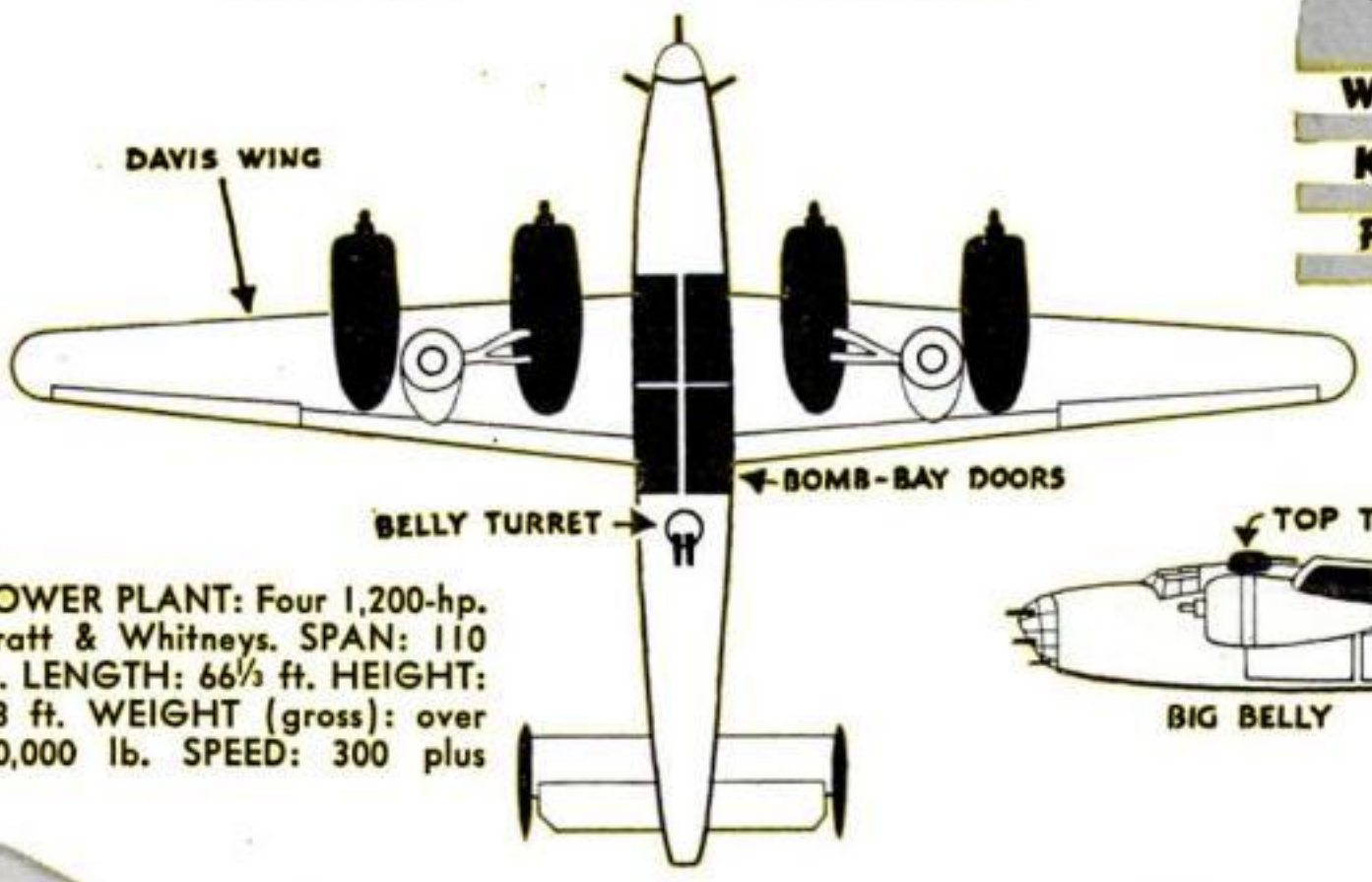
The LIBERATOR

cial preservatives applied to the engines, lighter oils and hydraulic fuels poured into her tanks. For desert duty, special filters are installed to keep sand out of her induction and fuel systems. These modifications are made at several depots, and when they're completed, the Liberator is ready for the firing line.

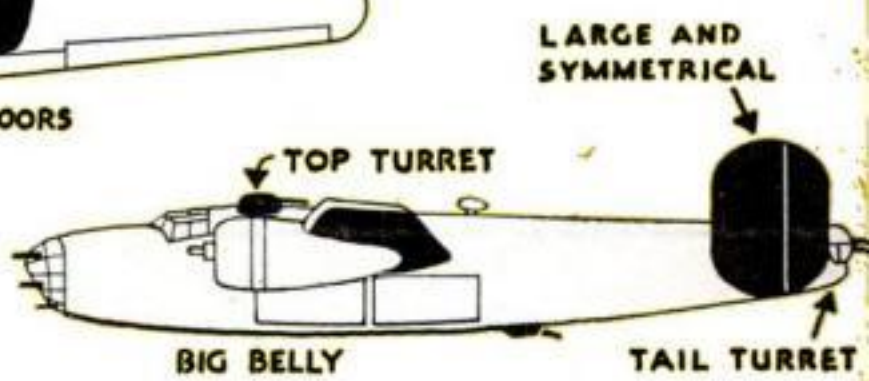
During a brief battle career this four-engine monster already has proved her deadly efficiency. The British first used her to stalk submarines. They equipped her with depth bombs, and in a matter of weeks sank a large number of German subs in the Bay of Biscay alone. Almost before the camouflage dried on her rounded belly, every Englishman was convinced she was in truth a Liberator.

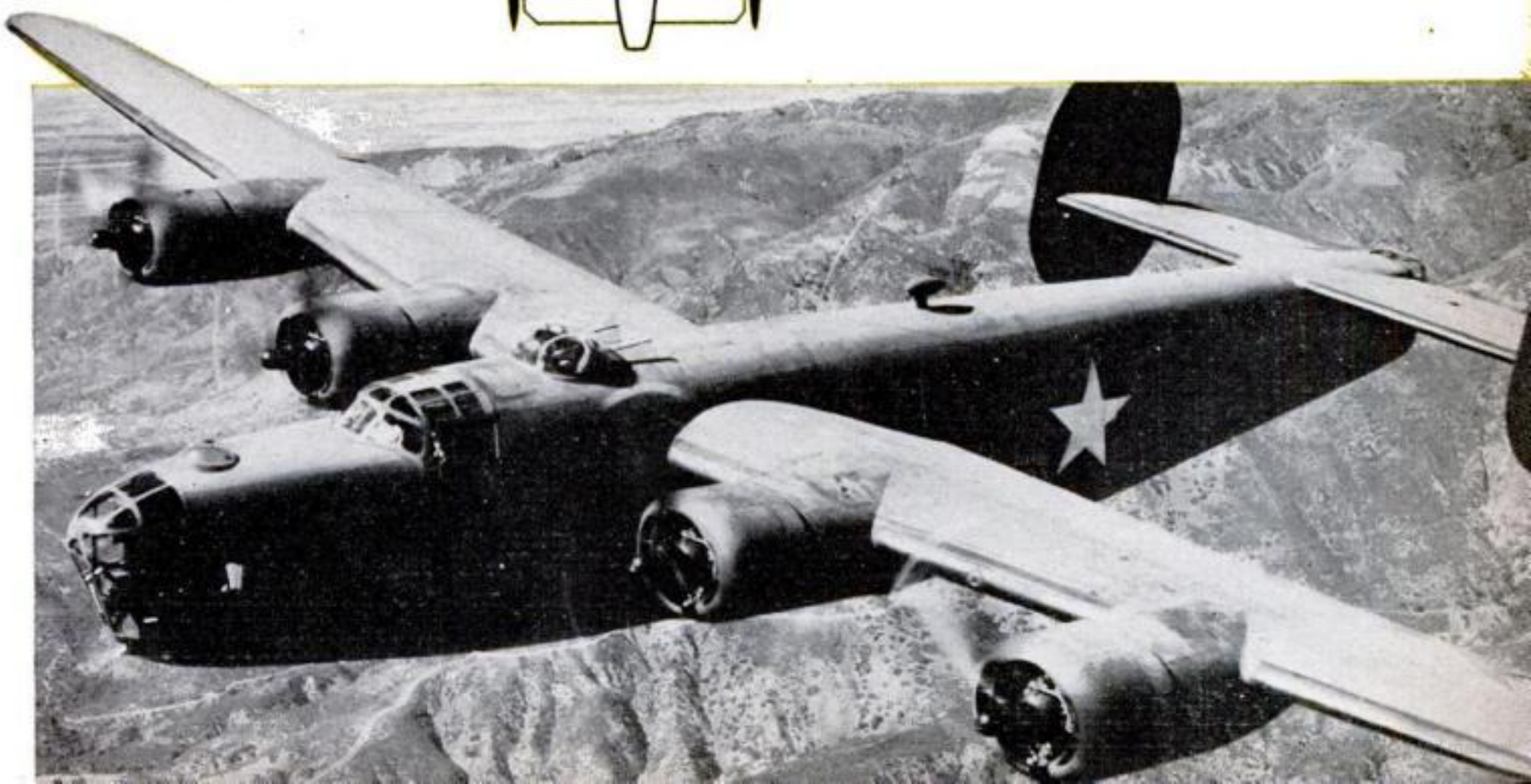
Improved Liberators began to reach American battle lines in mid-1942. Almost overnight, great stories of their hard-hitting

WHAT YOU SHOULD KNOW ABOUT OUR FIGHTING PLANES



POWER PLANT: Four 1,200-hp. Pratt & Whitneys. SPAN: 110 ft. LENGTH: 66⅓ ft. HEIGHT: 18 ft. WEIGHT (gross): over 50,000 lb. SPEED: 300 plus





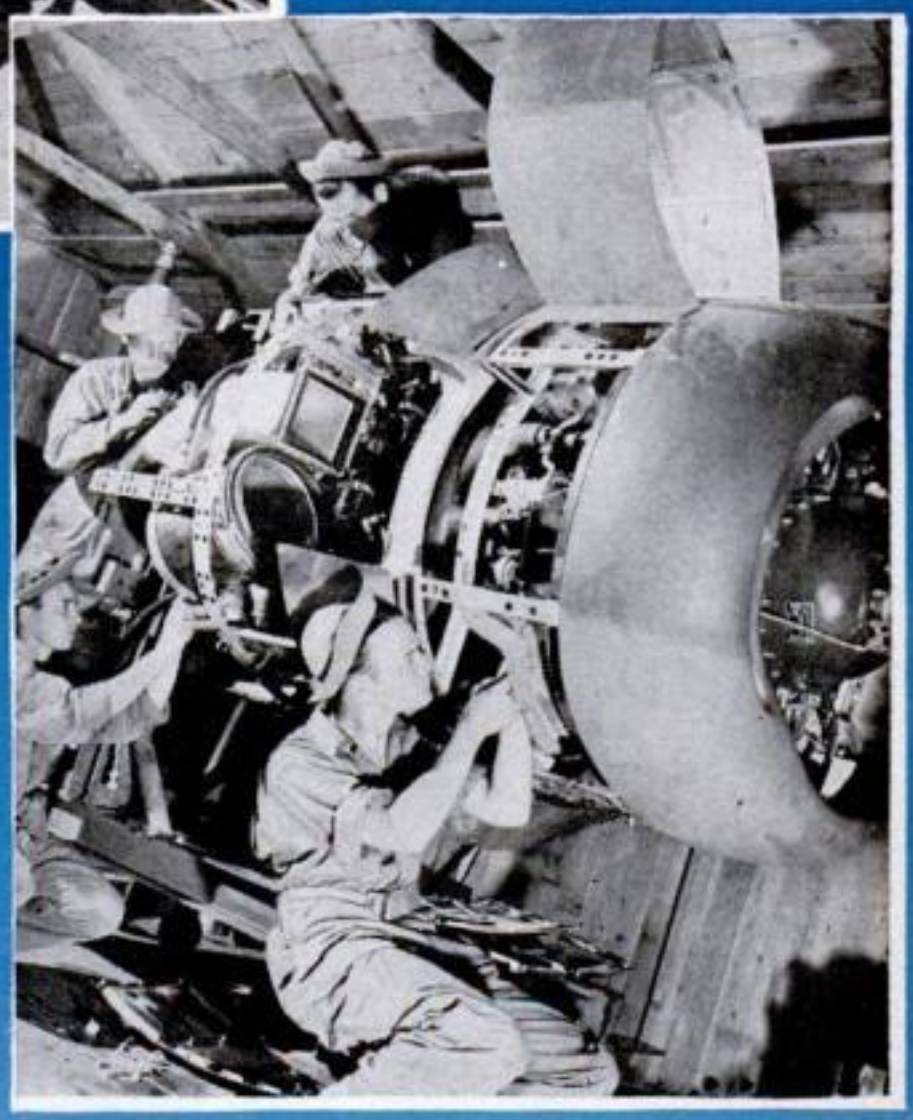
accuracy with bombs of all sizes began clicking across the cables and radio. Bombs from Liberators rained on Roumanian oil fields last June. That was a pasting heard around the world, for it announced that Uncle Sam was about ready to tackle Europe with daylight raids, sending over increasing numbers of precision bombardiers. Soon the Liberators' attacks increased in both the Far and the Near East.

You'll have to skip around the map a bit to follow their trail of destruction. Liberators helped punish the Japs at Attu, Agattu, and Kiska, stemming a northern advance that might have doomed Alaska and threatened the American mainland. Working with Lockheed P-38 Lightnings, the Liberators made sweep after sweep over Kiska, sinking Japanese transports, destroyers, and cruisers; wrecking important military installations; kindling large fires and spreading terror among the little brown enemy. Punching holes in enemy installations and ships from six miles up became commonplace.

Meanwhile, American airmen riding high in Liberators swooped across Libya and began slugging Axis shipping in Suda Bay, Crete. Other squadrons started dogging Rommel, unloading hot cargoes on Tobruk, strafing shipping with their bombs and machine guns, and making deadly passes at German and Italian tanks. One returned to its base carrying 200 bullet holes, but was

CAMP CONSAIR TRAINS MECHANICS TO SERVICE LIBERATORS

Retired to school service after being damaged in a fire, this Liberator with its fuselage and nose panels removed gives the student mechanics a good idea of the location of all the complicated parts of the ship they are to service. In classroom shops, like the one shown below, they overhaul and repair 1,200-horsepower engines, doing all the jobs they will encounter when they work on the big bombers on the war front



IT TAKES 15 highly trained mechanics to keep one Liberator in the air. To insure adequate ground crews for our armadas of B-24's, Consolidated Aircraft Corporation, originator and one of the builders of the plane, co-operate with the Army in operating a mechanics' training school at a California plant. Called Camp Consair, this school takes men from basic mechanics' schools and from the Army, and gives them several weeks of intensive training in the maintenance and overhaul of the big bombers. As a graduation present, each man is offered a ride over southern California in a Liberator he has helped to put in good working order. Acceptance is voluntary, but who would dare refuse to fly in a plane that he had helped to fix?

still flying and fighting when the enemy disappeared.

In a matter of days, Liberators bombed three Italian cruisers in the harbor at Pylos, Greece; joined the Russian air force at Sevastopol; smashed at Bengasi; laid more than 50,000 pounds of steel eggs in a second slap at Suda Bay; roared over France to attack Lille, Saint Nazaire, and La Palisse; smashed installations at Hong Kong; raided the Linshi coal mines in China. Now they are hitting at the Axis in Tunisia, delivering supplies and fighting men to distant Allied Pacific bases, striking the enemy wherever he can be found.

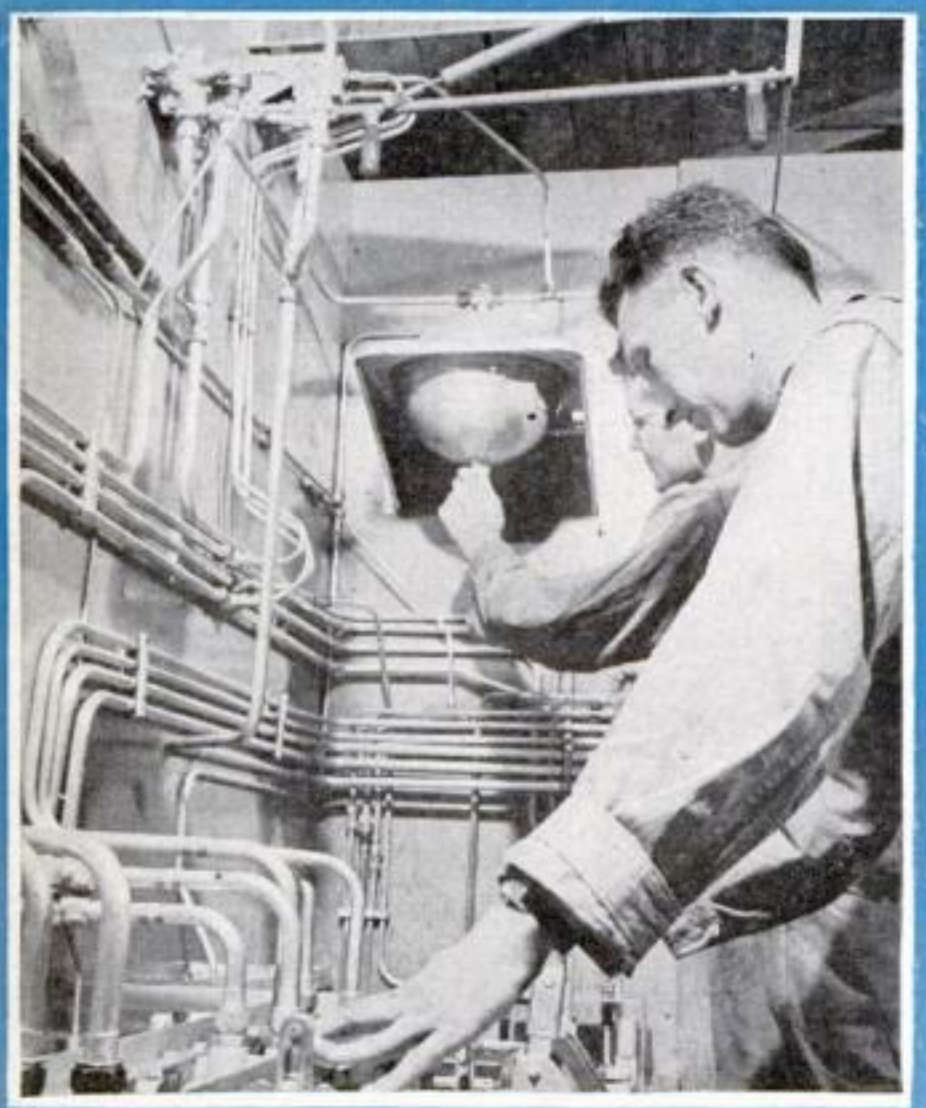
Hitler never will forget that Lille affair. It was on October 9, 1942, when 115 Liberators and Fortresses made a tight-formation attack. Five hundred fighters accompanied them part way, then swung aside to shoot up several airdromes, hoping to lure German fighters away from the main attack. The bombers smashed a plant engaged in building 150 main-line locomotives a year, downed 48 Focke-Wulf and Messerschmitt fighters, damaged and probably destroyed 59 others. American losses? Two Liberators, two Fortresses.

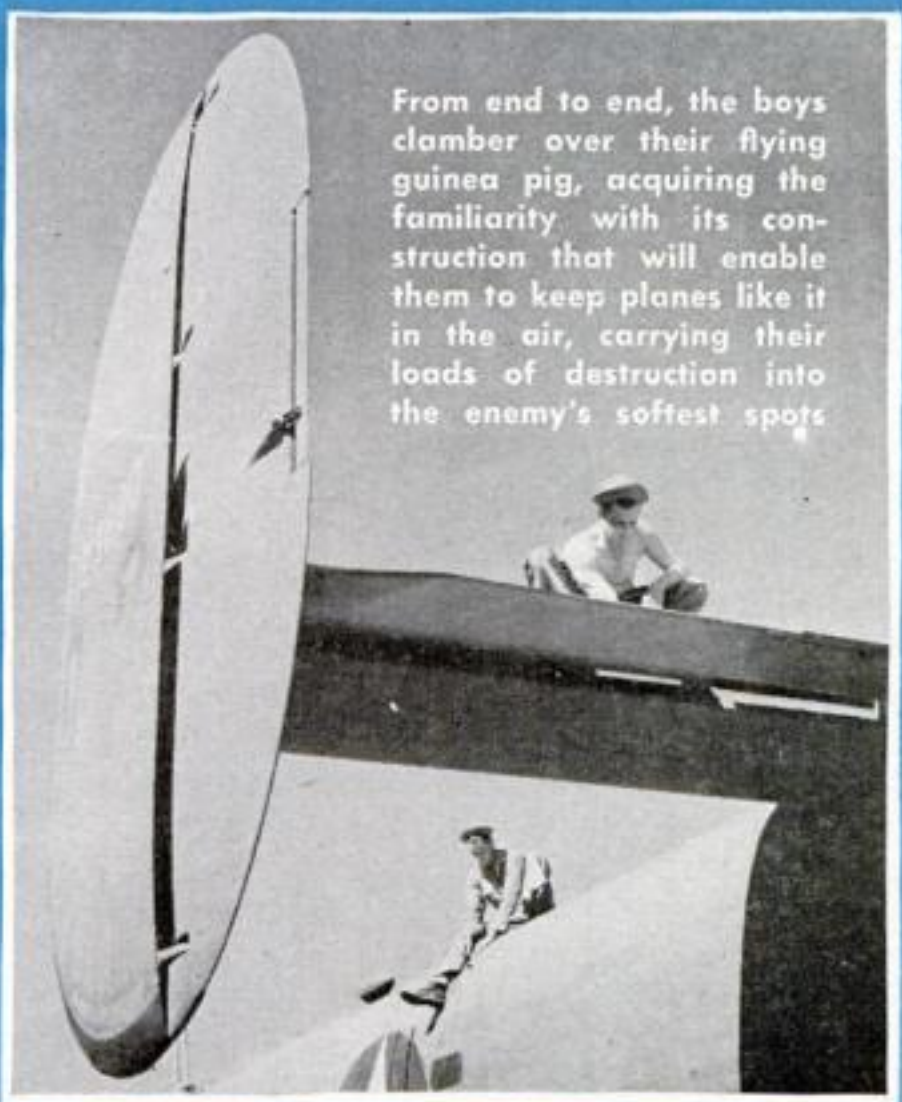
Though her guns are deadly, her wing is the real secret of the Liberator's success in waging long-range aerial warfare. We've got to go back a bit for that story.

In the fall of '38, the Air Corps, scanning the coming clouds of war, wheedled from

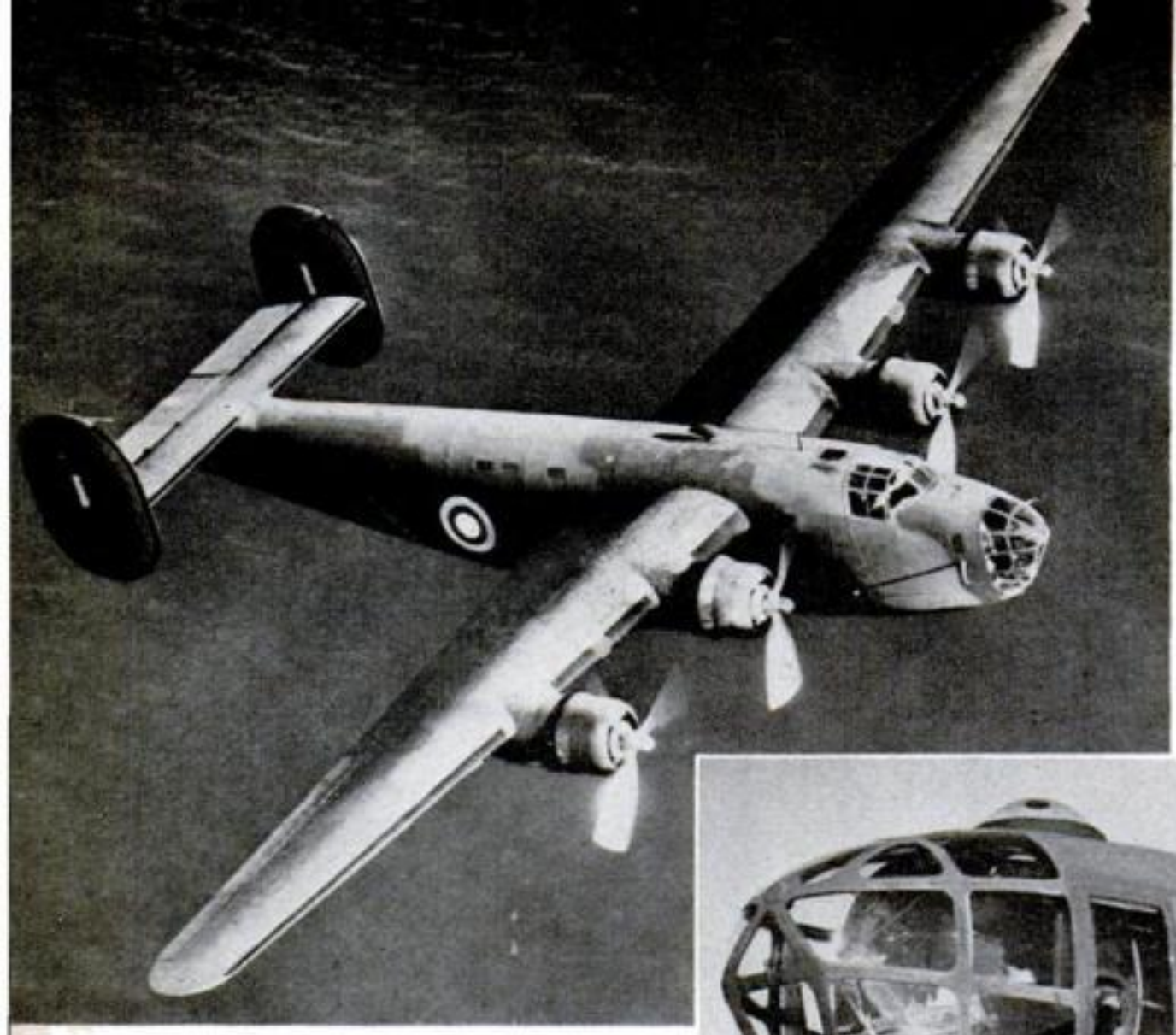
IN THE FIELD

At the right, students take out one of the self-sealing fuel cells. Another feature that gets plenty of attention is the hydraulic system. In a mock-up system that exactly matches the installation in the B-24, they trace the maze of pipes and learn just what each part does when the ship is in flight. Below, one of the mechanics examines the ball-shaped pressure accumulator while another trips a control that sets an electric motor spinning with a pump





From end to end, the boys clamber over their flying guinea pig, acquiring the familiarity with its construction that will enable them to keep planes like it in the air, carrying their loads of destruction into the enemy's softest spots



FIRST LIBERATORS to reach England looked like the camouflaged submarine hunter at left. Note the absence of top and tail guns, which were added later. Below, a modern B-24 loads up for a raid at a U. S. Army Air Forces station in England. The men are preparing a 1,000-pound present for Hitler. In a raid on Lille, France, in company with Flying Fortresses (115 planes in all), the Liberators helped wreck a big plant building locomotives for the Nazis. Incidentally, they and the B-17's brought down or damaged 107 German fighter craft

Congress an appropriation to raise our force of military planes from 2,500 to 10,000. Of these only 100 were to be big bombers. Lieut. Gen. H. H. Arnold, Chief of the Air Forces, ordered 100 Fortresses, the only big fellows then available, and induced Boeing and Consolidated to make them, one by Consolidated for every two by Boeing. Then the Federal lawmakers whacked the appropriation in half, Boeing got the order, and Consolidated sat out in the cold.

But Arnold had a substitute plan ready. He called Edgar N. Gott, Consolidated vice-president, and asked, "Can you fellows turn out a long-range land bomber, and how soon?" "We can deliver a bomber in nine months," Gott answered promptly. All he had to rely upon for the promise was Consolidated's experience in building the Model 31 long-range twin-engine flying boat. Bombers those days could scarcely clip off 1,200 miles. Gott knew he'd have to turn out one capable of reaching Ireland or Hawaii, in order to meet the demands of the changing pace of air war.

Nine months and 10 acres of blueprints slipped by, and the B-24 arrived. Would she deliver, as the Army demanded, 307 miles an hour top speed, reach a 30,000-foot ceiling, cruise at 220 m.p.h. three miles up, and maintain a three-mile altitude with two engines out? Could she cruise 3,000 miles without refueling?

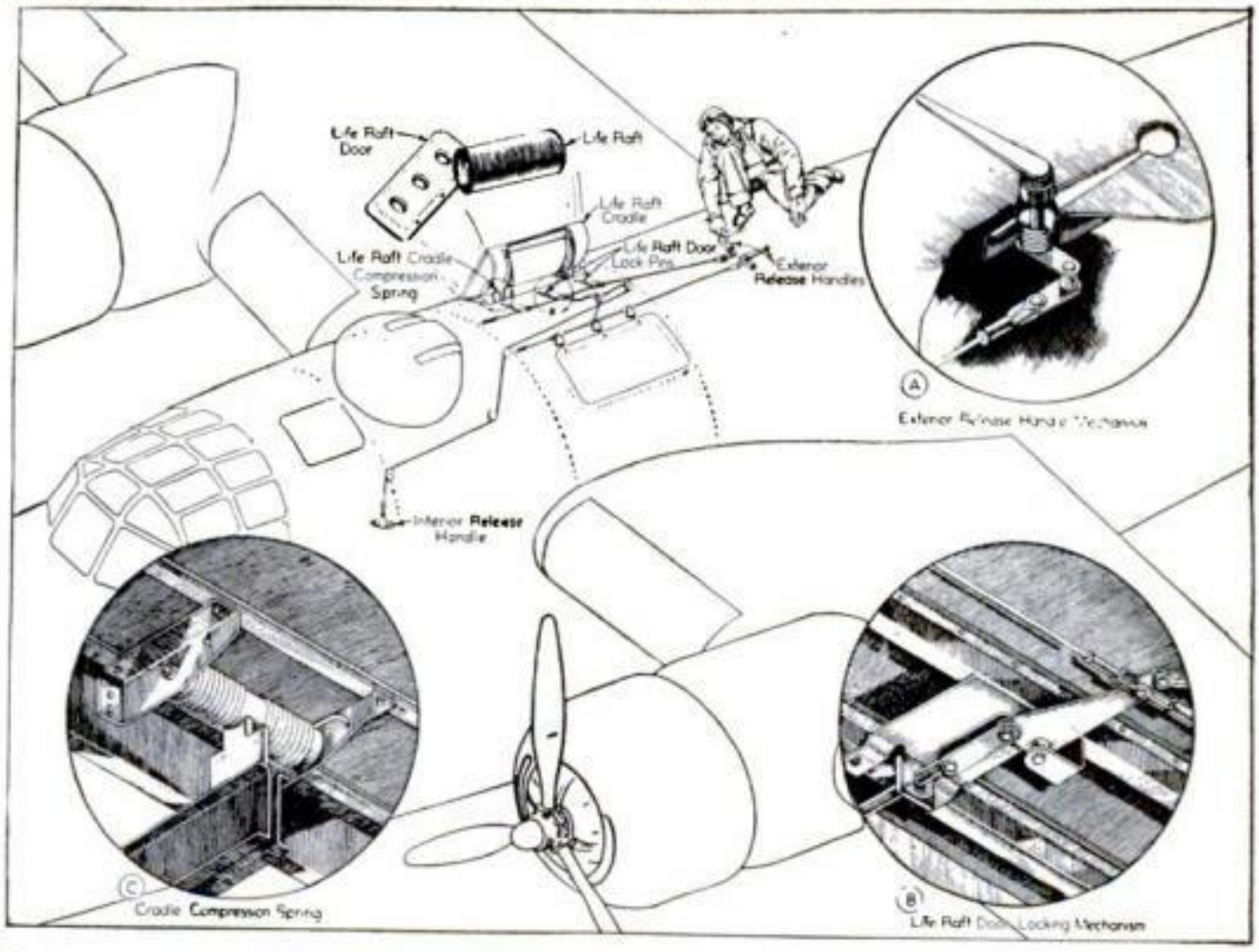
Her slick aluminum skin shone brightly in the California sunshine, her tail arched gracefully from her plump belly, her wings stuck out stiff and stark. She was slightly on the heavy side, but on that warm California morning she flew gracefully, and that instant was recorded a series of firsts which marked her an airplane to be reckoned with. For the Liberator was the first heavy plane to use tricycle landing gear, first to employ Hamilton hydromatic quick-feathering three-blade propellers, one of the first to use Model R-1830 1,200-hp. Pratt & Whitney radial engines. *(Continued on page 210)*

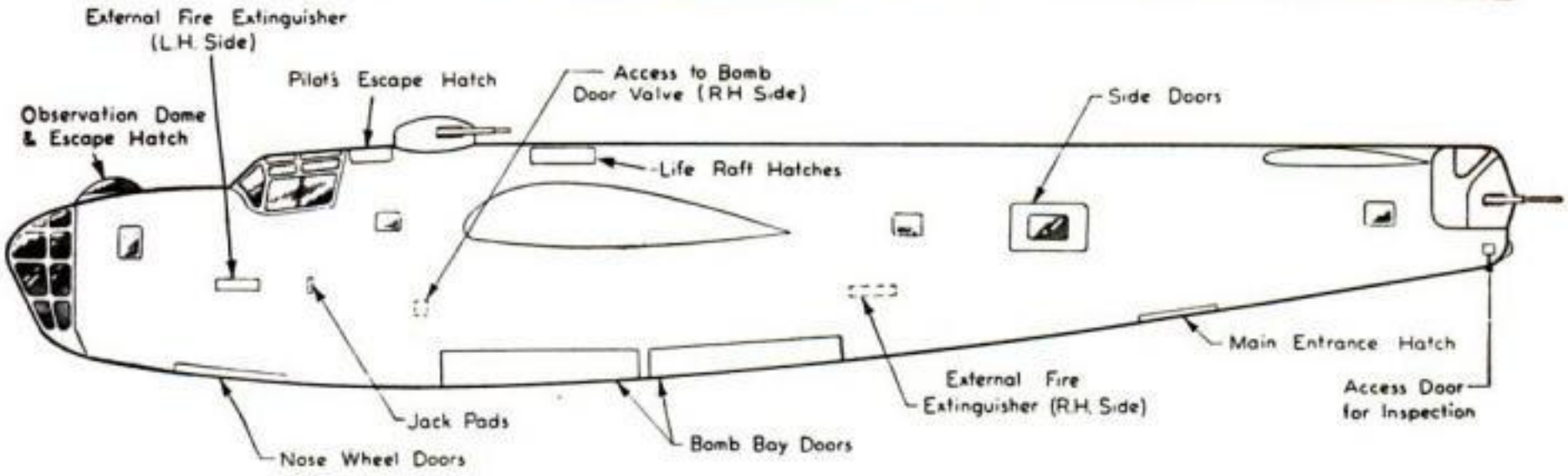
THE "EXPRESS LIBERATOR": A CARGO-PLANE VERSION

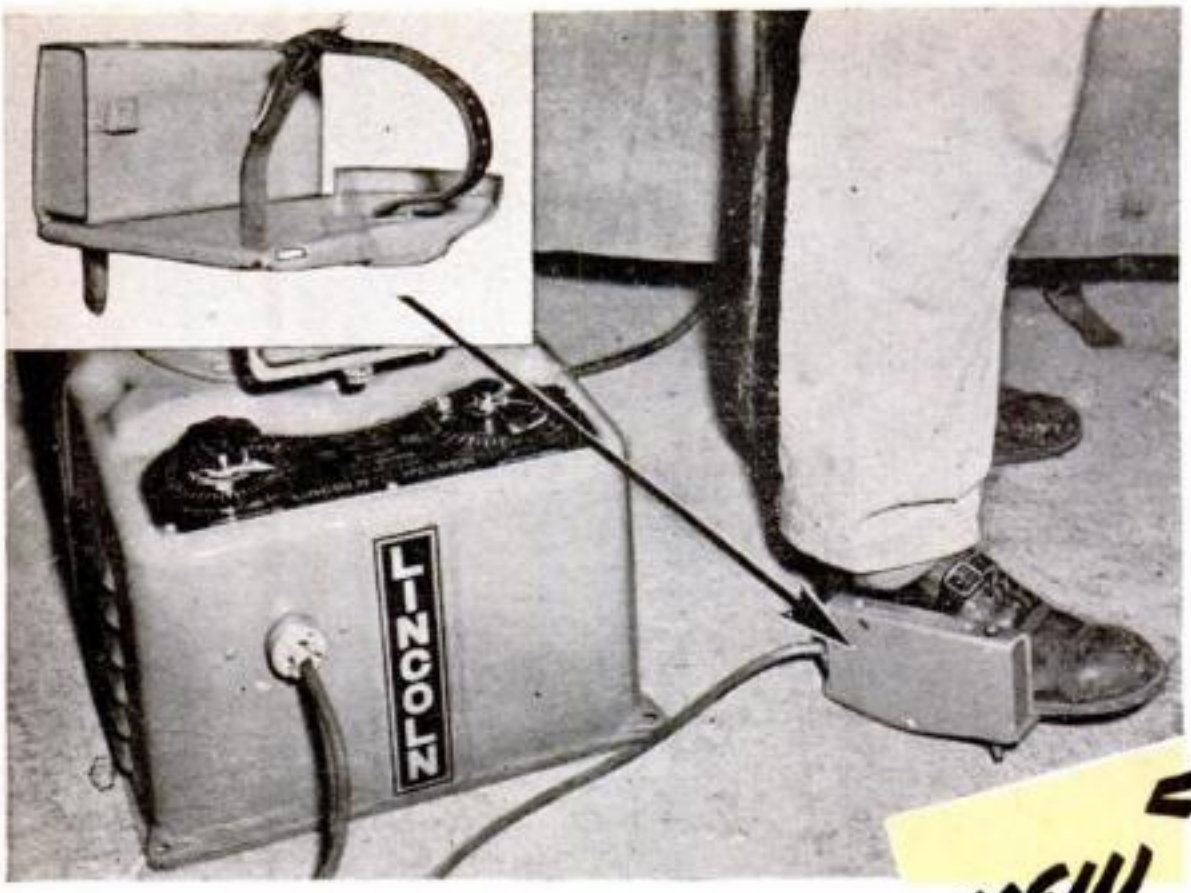
An adaptation of the B-24 for cargo and personnel carrying, the C-87 "Express Liberator" makes scheduled ocean runs transporting officers, ammunition, and repair parts to the fighting fronts. It carries a pay-load cargo of 10 tons with speed above 300 m.p.h. Lieut. Gen. H. H. Arnold, chief of the Air Forces, is seen at right inspecting the interior of a C-87

LIFE RAFTS CAN BE RELEASED FROM INSIDE OR OUTSIDE PLANE

In addition to its deadly destructive power, the Liberator has many features to provide for safety. One of these is the ingenious arrangement shown at the right, by which life rafts can be released from the outside when the plane is forced down on the water. Release handle (A) on back of plane operates the life-raft door-locking mechanism (B) and a cradle compression spring (C) tosses the raft out. The drawing below shows location of doors, hatches, fire extinguishers, and other factors in safety for personnel





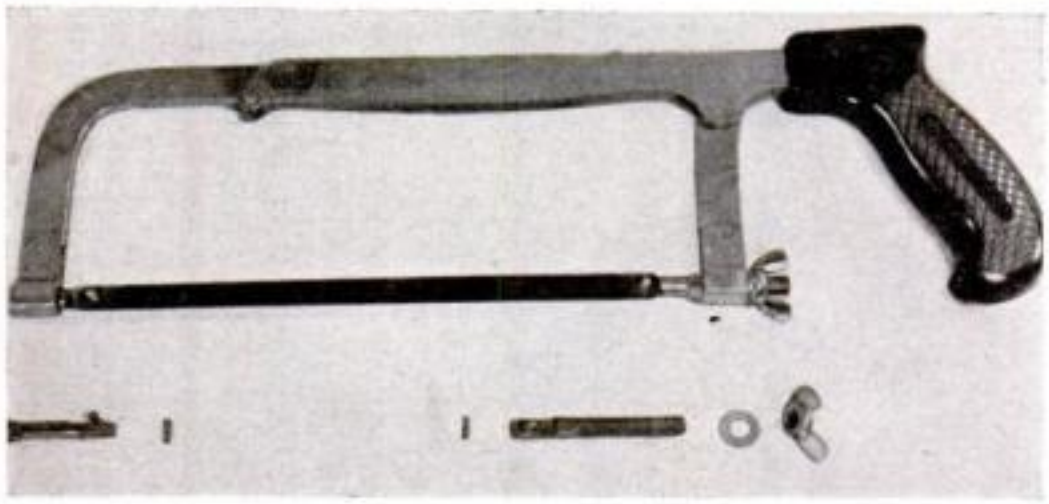


A FOOT CONTROL that regulates the current, and thus enables the operator to make adjustments in the arc quickly, has been designed for arc welders by the Lincoln Electric Company of Cleveland. Intended primarily for aircraft work, the lightweight pedal is strapped to the operator's foot to give him freedom of movement. The control is fitted with a 40-foot cable.

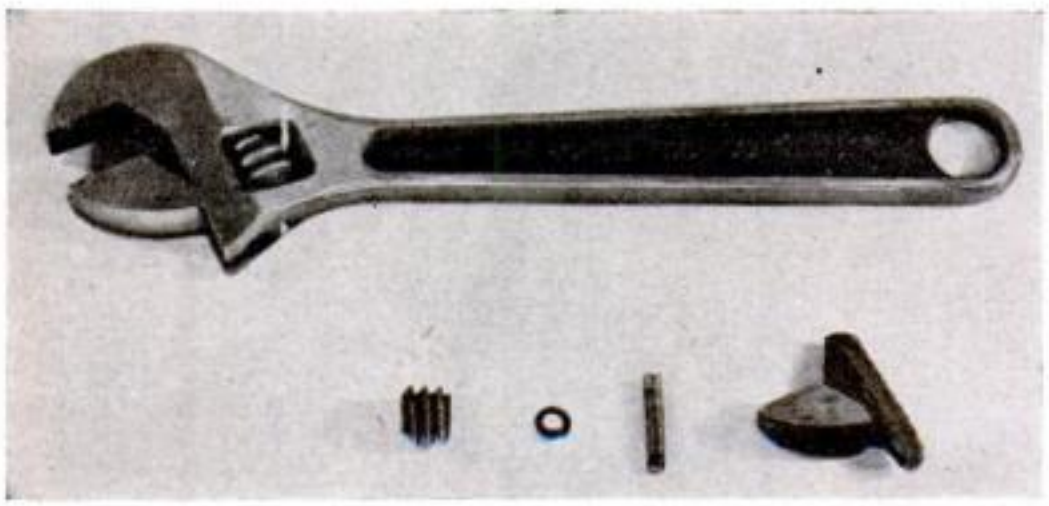
NEW Tools

TOOL OWNERS CAN BUY REPLACEMENT PARTS

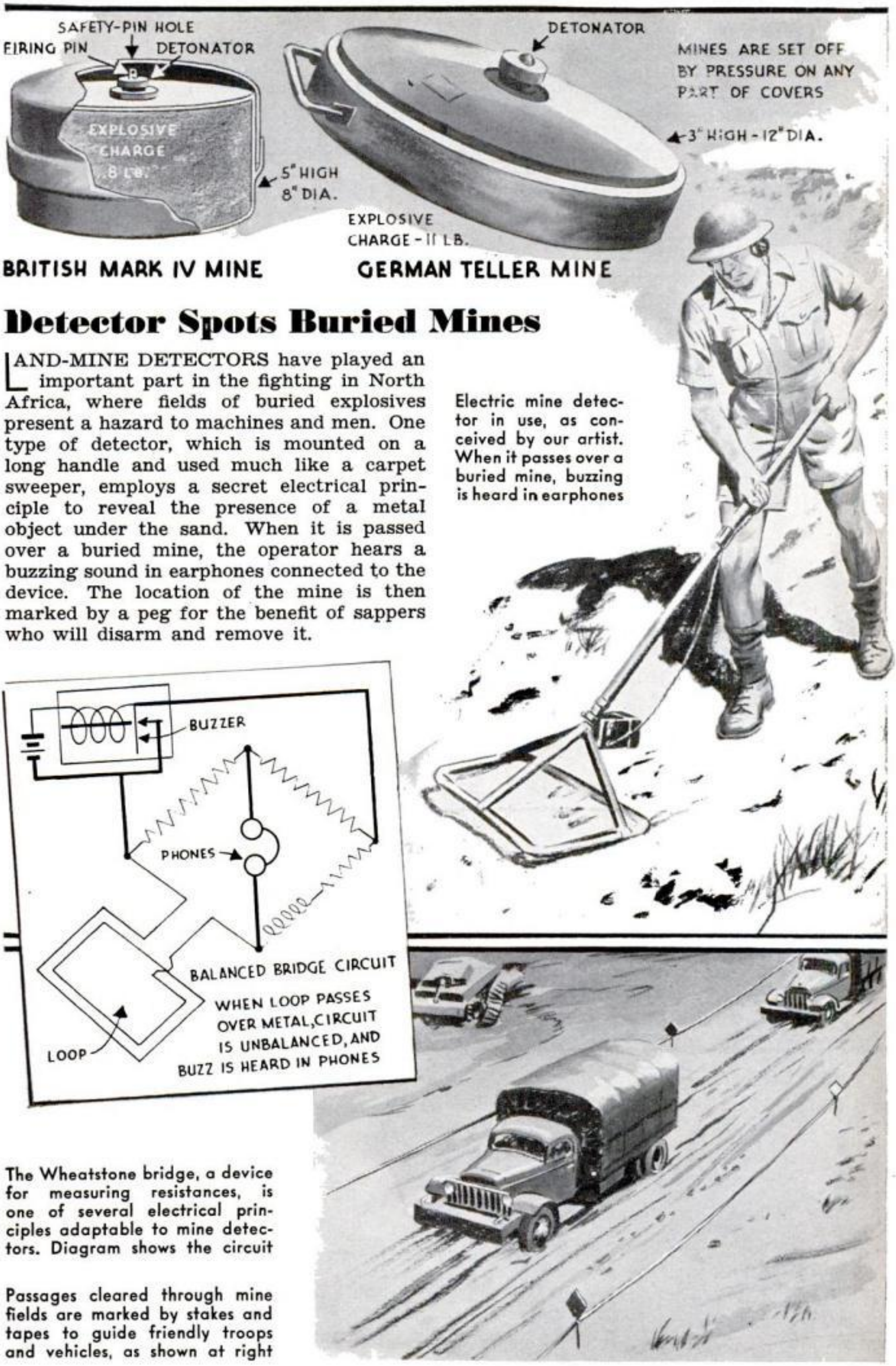
TO HELP tool users keep their present equipment in service for the duration, one manufacturer is supplying replacements for parts that are most likely to break, wear out, or become lost. For hack saws, new wing nuts, washers, and pins are available, as well as new blades. New jaws, washers,



and pins can be obtained for wrenches. Pliers and shears are kept working with new bolts and nuts. With the supply of new tools limited, this timely service should prove a valuable conservation measure to keep tool users happy.



INDICATORS used in precision machine work can now be positioned faster and more accurately with a holder recently brought out by the Oslund Tool & Die Company of Hartford. A lock screw holds the indicator in approximate position while a micro screw adjusts it precisely. A timesaving device is provided in a curved-bar scale that has 360-degree visibility, thereby making it unnecessary for the operator to move around the indicator to make readings.



Detector Spots Buried Mines

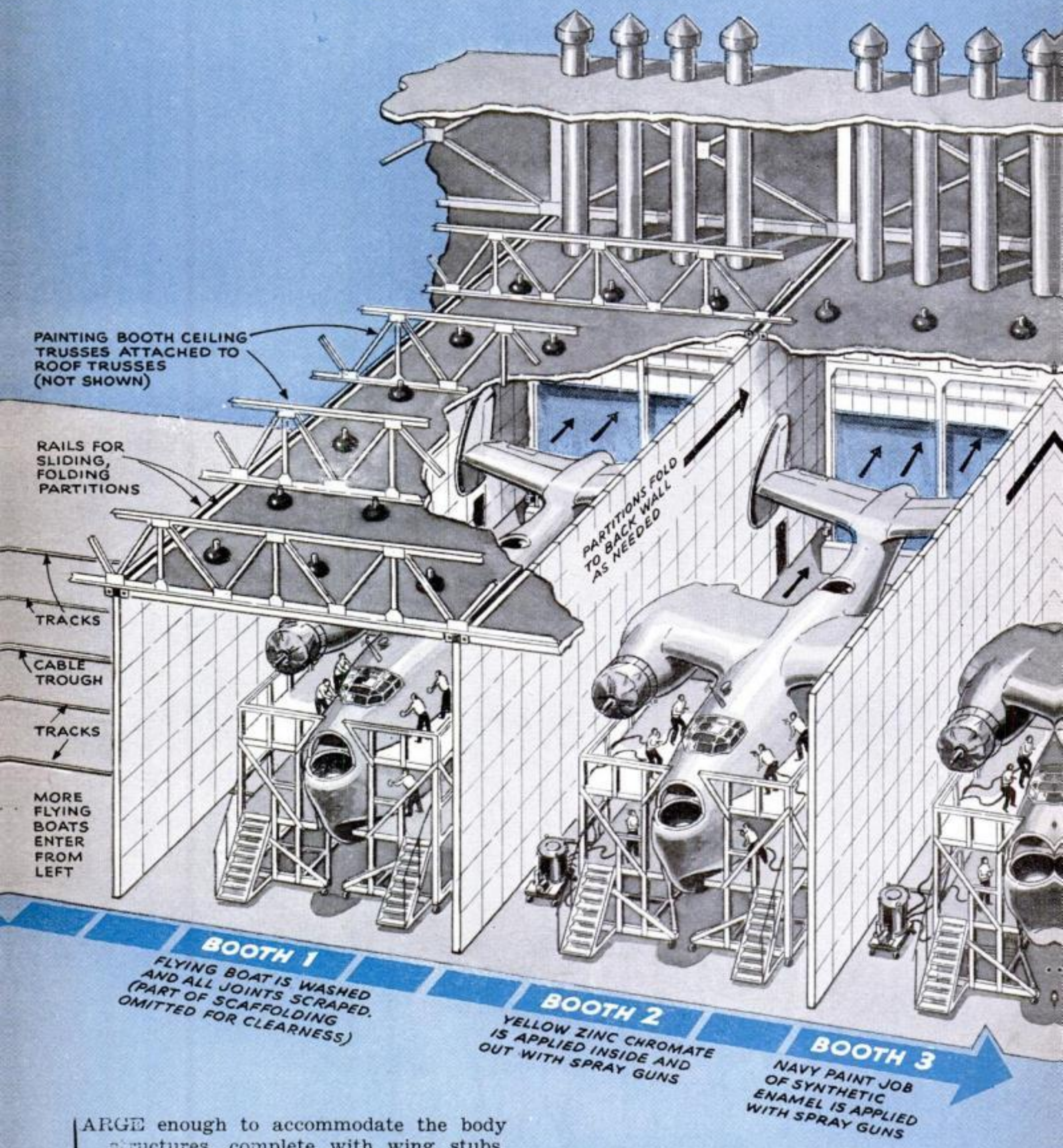
LAND-MINE DETECTORS have played an important part in the fighting in North Africa, where fields of buried explosives present a hazard to machines and men. One type of detector, which is mounted on a long handle and used much like a carpet sweeper, employs a secret electrical principle to reveal the presence of a metal object under the sand. When it is passed over a buried mine, the operator hears a buzzing sound in earphones connected to the device. The location of the mine is then marked by a peg for the benefit of sappers who will disarm and remove it.

Electric mine detector in use, as conceived by our artist. When it passes over a buried mine, buzzing is heard in earphones

The Wheatstone bridge, a device for measuring resistances, is one of several electrical principles adaptable to mine detectors. Diagram shows the circuit

Passages cleared through mine fields are marked by stakes and tapes to guide friendly troops and vehicles, as shown at right

Painting the Big Planes

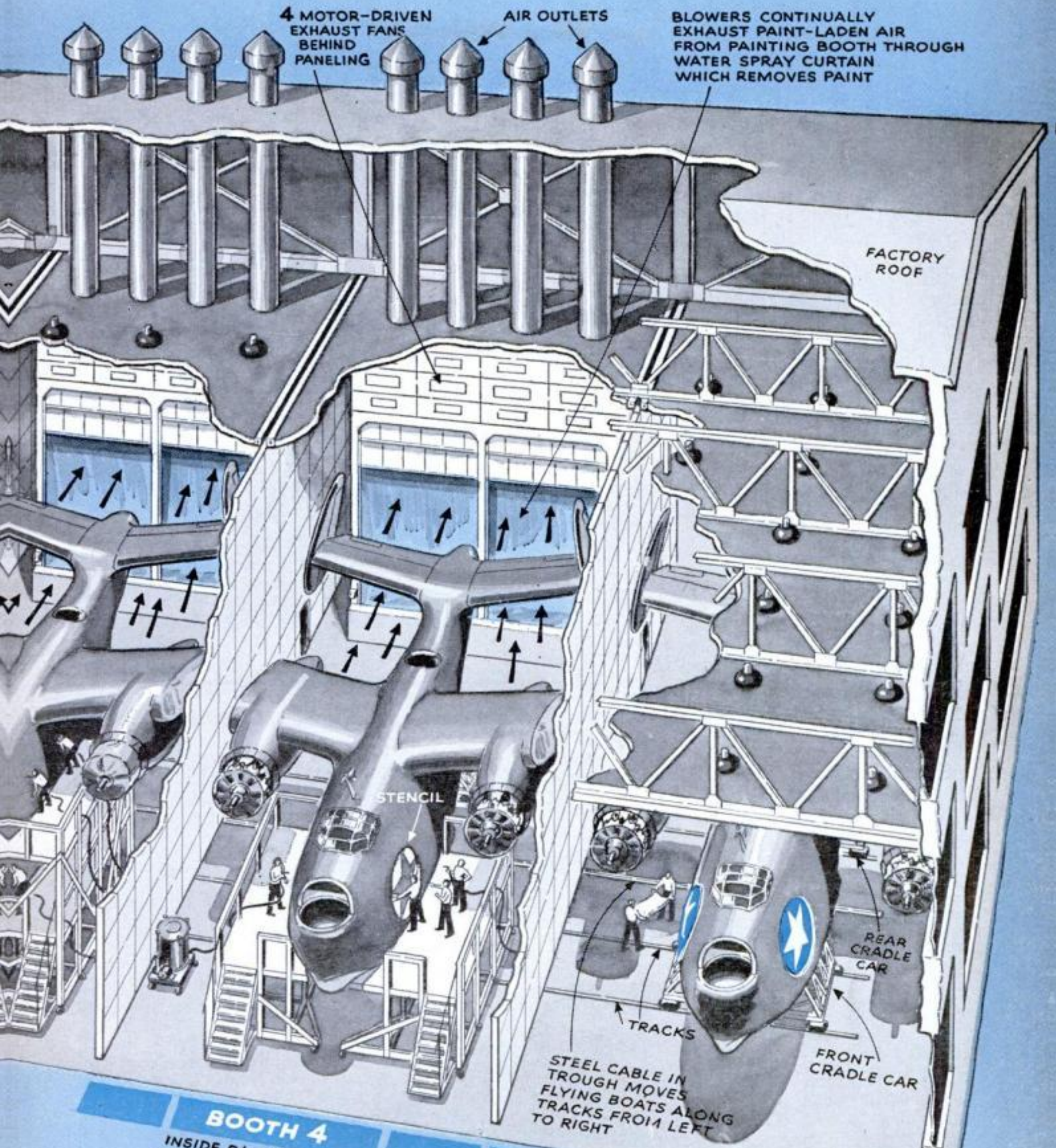


LARGE enough to accommodate the body structures, complete with wing stubs, engines, and tail assembly, of five big Navy patrol planes at once, a block-long shop in the Glenn L. Martin plant helps speed aircraft to the fighting fronts. As they move through the building-within-a-building, flying boats receive three paint jobs and two other finishing treatments in assembly-line style.

Each operation, performed in a separate booth, takes approximately the same time. To assure this, men and women workers may be shifted as needed from one booth to another. When work in all booths is done, out comes a finished plane body at the end of the line.

Now the whole scene shifts. Partitions, which have separated the booths, telescope toward the rear like the panels of folding household screens. This clears a pair of railway tracks running lengthwise through

World's Largest Spray Booth Works at Assembly-Line Speed



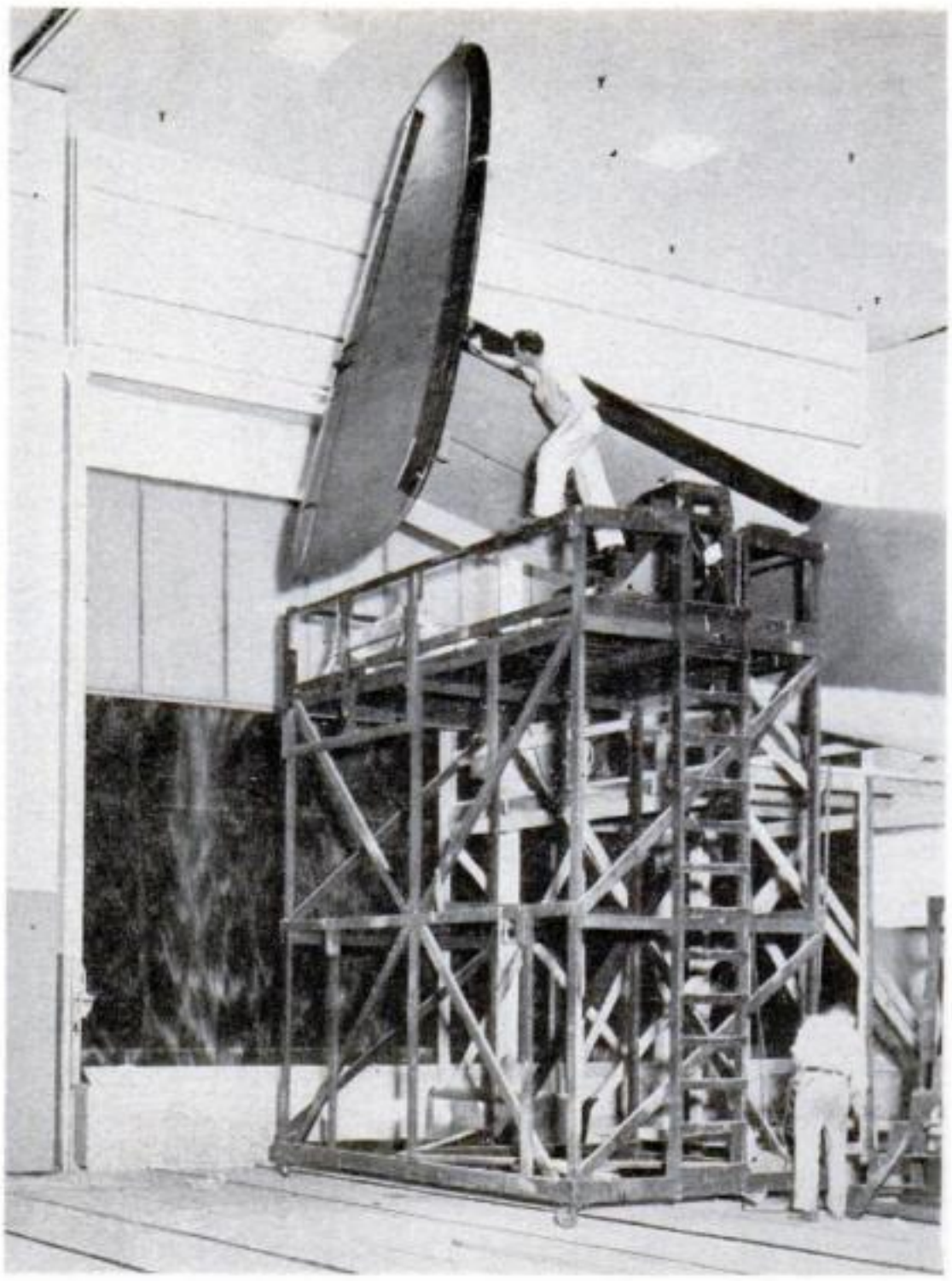
BOOTH 4

INSIDE PAINT JOB OF LIGHT BLUE LACQUER, AND STAR INSIGNIA APPLIED WITH STENCIL AND SPRAY GUNS

SOUNDPROOFING BOOTH

SEVERAL INCHES OF FIBER GLASS SOUNDPROOFING IS APPLIED TO INSIDE OF CABIN

From scaffolding in one of the four spray-booth compartments, a worker touches up the de-icer on the leading edge of a horizontal stabilizer. Drawing below gives details of the spray curtain for purifying the air



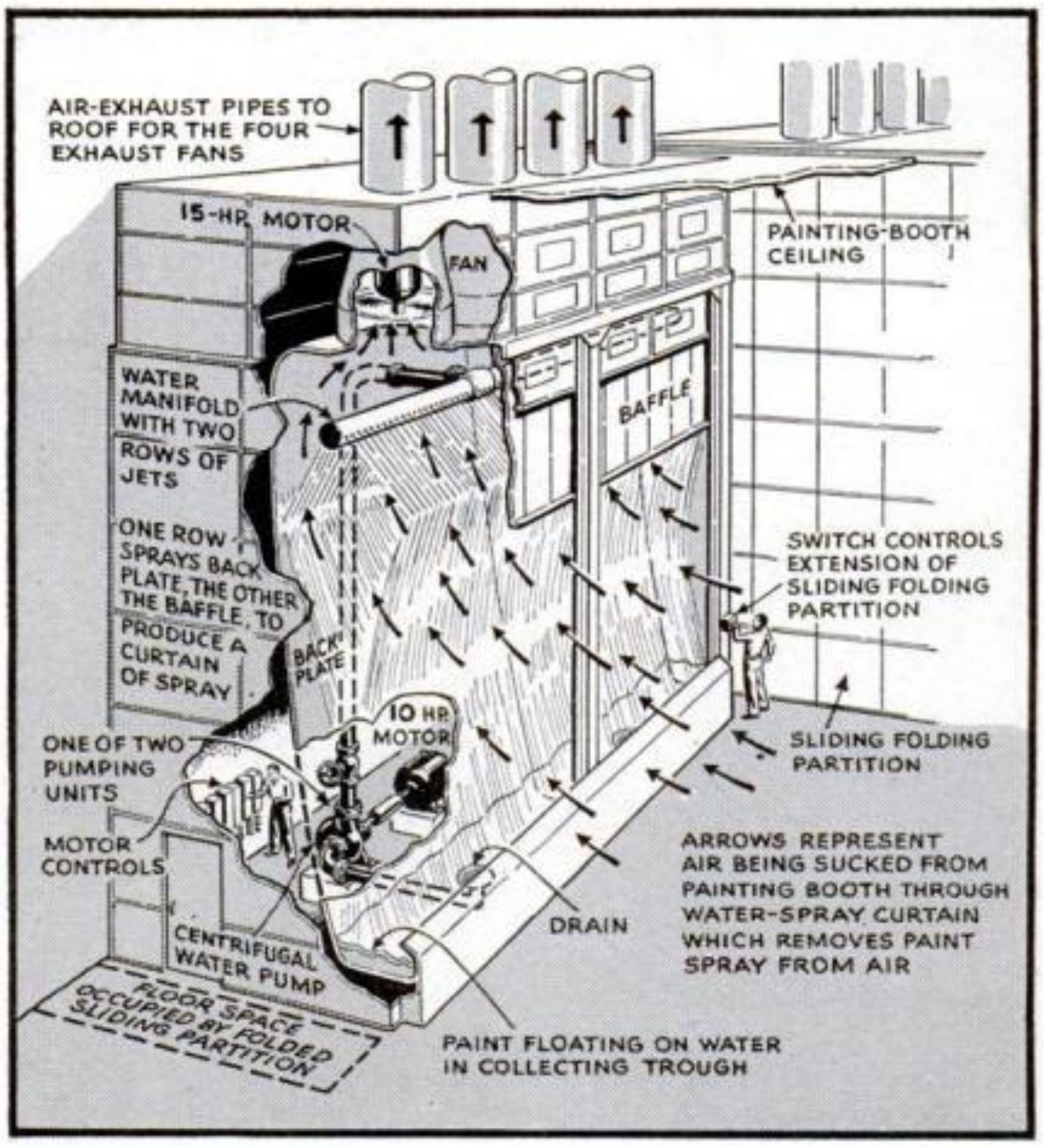
the building. Front and rear cradles, supporting each fuselage, rest on these tracks. Now, a special tow car is made fast between the cradles and is attached to an endless cable. An electric-powered winch draws ahead the cable, tow car, cradles, and plane body, until each fuselage has been advanced to the next booth. The same procedure brings a newly assembled plane body, from outside the building, past a telescoped wall into Booth 1. With wall and partitions back in place, the production cycle goes on.

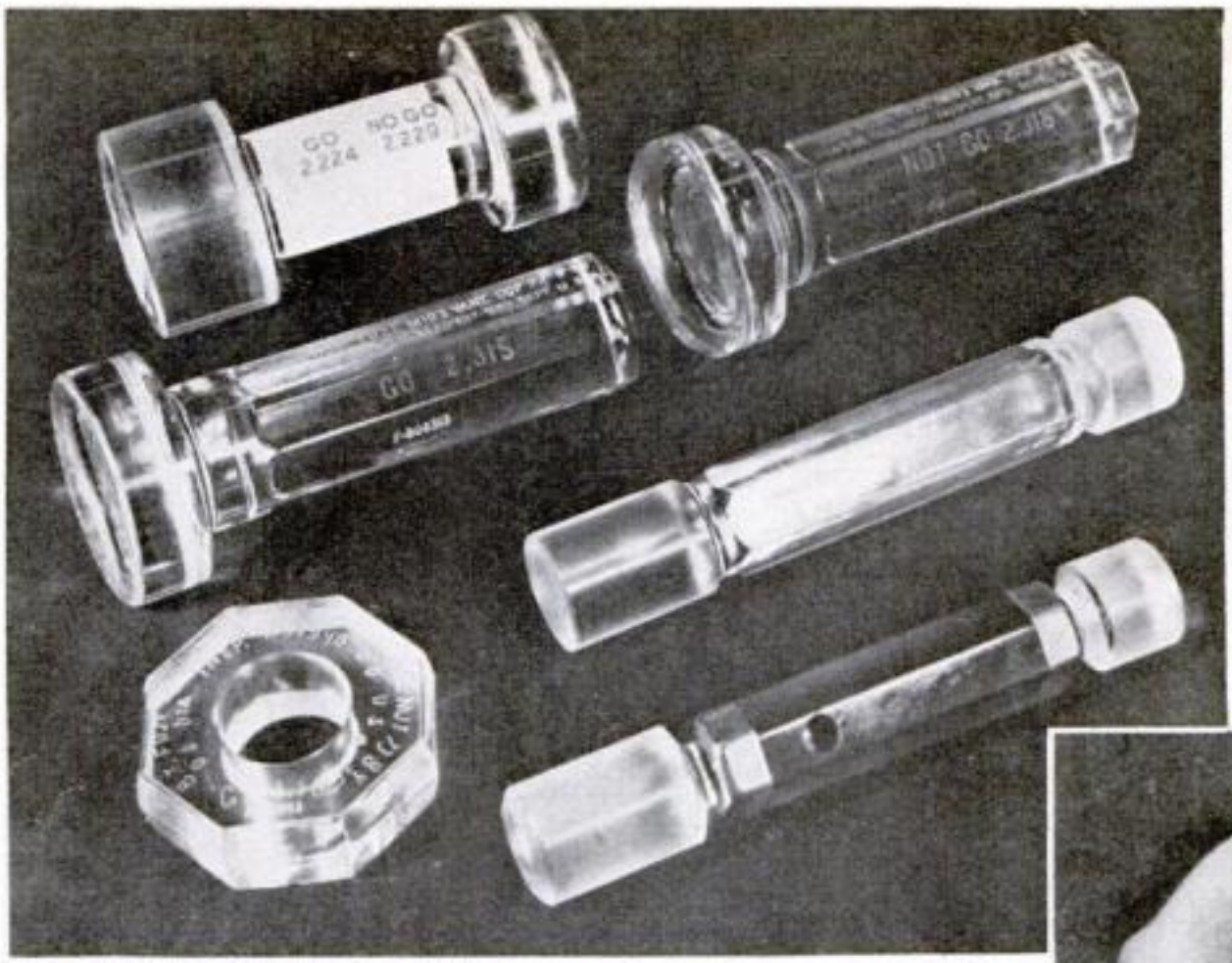
Accompanying drawings show what happens in the booths. The yellow zinc chromate coat provides resistance to corrosion. A finishing coat of enamel, bluish slate above and a lighter shade of bluish gray beneath, makes the plane difficult to detect against sea or sky.

After the main part of the plane leaves the booths, the wing panels, which have been painted in another part of the plant, are attached, instruments are checked, armament is installed, and another PBM-3 Mariner is ready for its test flight.

To avoid fire hazards from paint solvents, and to protect the workmen by making the air in the booths purer to breathe, each of the compartments is equipped with a curtain of water through which powerful fans constantly exhaust spray-laden vapors. Valuable pigments, instead of disfiguring the surrounding territory, are trapped in the water sprays and recovered.

Although only Navy patrol planes are being painted in the shop, which is the largest of its kind in the world, it could handle any U. S. warplane except the giant B-19.



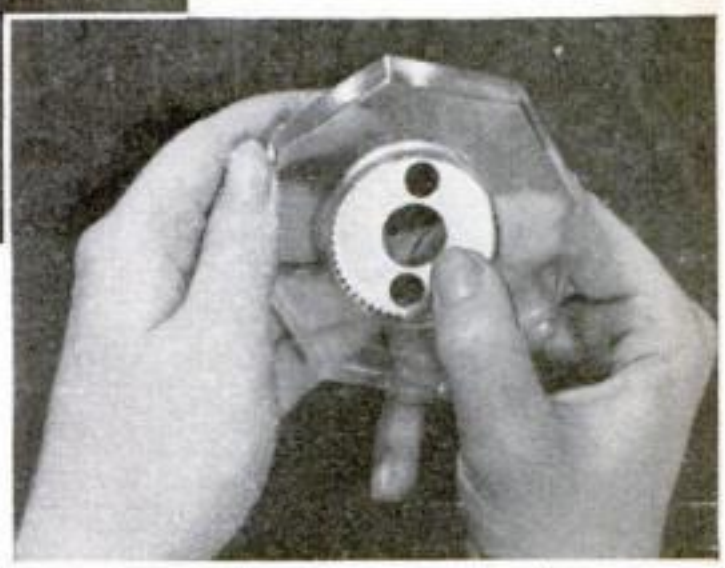


A set of six glass gauges now being used in the inspection of ordnance items. At left from top to bottom: double-end plug gauge, "go" plug gauge, ring gauge. At right, top to bottom: "not go" plug gauge, double-end solid-handle plug gauge, and double-end taper-lock gauge

Glass Replaces Steel in Precision Gauges

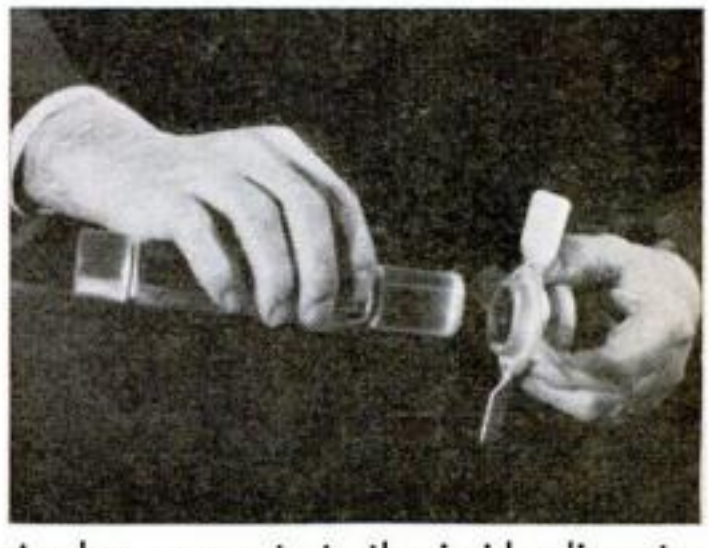
GLASS precision gauges have proved so successful in the inspection of war materials that their wide adoption in place of metal gauges is now being planned by both the Army Ordnance Department and private manufacturers. Made of pressed hard-flint glass, the new gauges offer many advantages over their metal forerunners. They require only one quarter as much machine-tool work, do not need to be greased to be kept from rusting, are lighter and therefore less tiring to handle, and permit the part being gauged to be visible to the inspector at all times. They are the equal of metal gauges in accuracy, and since glass has a low thermal conductivity, this accuracy is less affected by heat from the inspector's hand.

Checking the inner diameter of a cartridge case with a go and not-go gauge. Markings for the instrument appear on a label. Glass gauges save 250 tons of steel a year



Here a glass ring gauge is being used in the inspection of a steel gear at the Frankford Arsenal in Philadelphia

A not-go gauge. Details as to the purpose and dimensions of the gauge are marked on the side with acid etching



A plug gauge tests the inside diameter of a metal part. Gauges are produced by molding and pressing molten glass

Sleep Tips for Swing-Shifters

HERE'S HOW NIGHT WAR WORKERS CAN GET HEALTHFUL REST IN THE DAYTIME

WARMTH—POSITION

First requisite of sound sleep is adequate warmth. Even a mild chilling, which may not awaken the sleeper, may be enough to cause involuntary muscular tension. Lying on the right side interferes least with digestion and circulation

PHYSICAL RELAXATION

Hard work at a bench or lathe may result only in a nervous tiredness that makes sound sleep all but impossible. Daily setting-up exercises followed by a warm shower will help to relieve muscular tension, tone up your system, and induce a relaxed feeling that lets you drop off to sleep quickly

LIGHT

An eye mask is a better protection against daylight than window shades that are liable to rattle

NOISE

The wise night worker, who must sleep while other people are awake, takes precautions against ringing phones and door bells. Muffling is one solution. Another is to tell friends and tradespeople to call you only at certain hours

FOOD

Next to eating a heavy dinner just before going to bed, the worst thing to do is to go to bed hungry. A good compromise is a healthful salad and a glass of milk just before retiring. Milk has vitamin D, which many night workers lack

MENTAL RELAXATION

Don't take your troubles and worries to bed with you. Read an entertaining book or listen to soothing music to relax your mental tension. When you finally lie down, try to breathe slowly and deeply, and make a conscious effort to relax your muscles

VENTILATION

A bedroom should be thoroughly aired. A room that is close or too warm will leave you feeling heavy and thick-headed when you get up. And be wary of woolen sleeping garments. They may make you itchy and restless. Wear only clothes that are loose and comfortable

WHY PETROLEUM IS

America's Ace in the

CHEMICAL MAGIC TURNS "BLACK GOLD" INTO 1,000

By Alfred H. Sinks

A YEAR ago we had hardly begun to build an army. Today Americans are talking glibly of what we're going to do after we've *won* the war. To the Jap who thinks us soft and silly, to the Nazi filled with *ersatz* contempt for other nations, such cocky confidence would be a mystery.

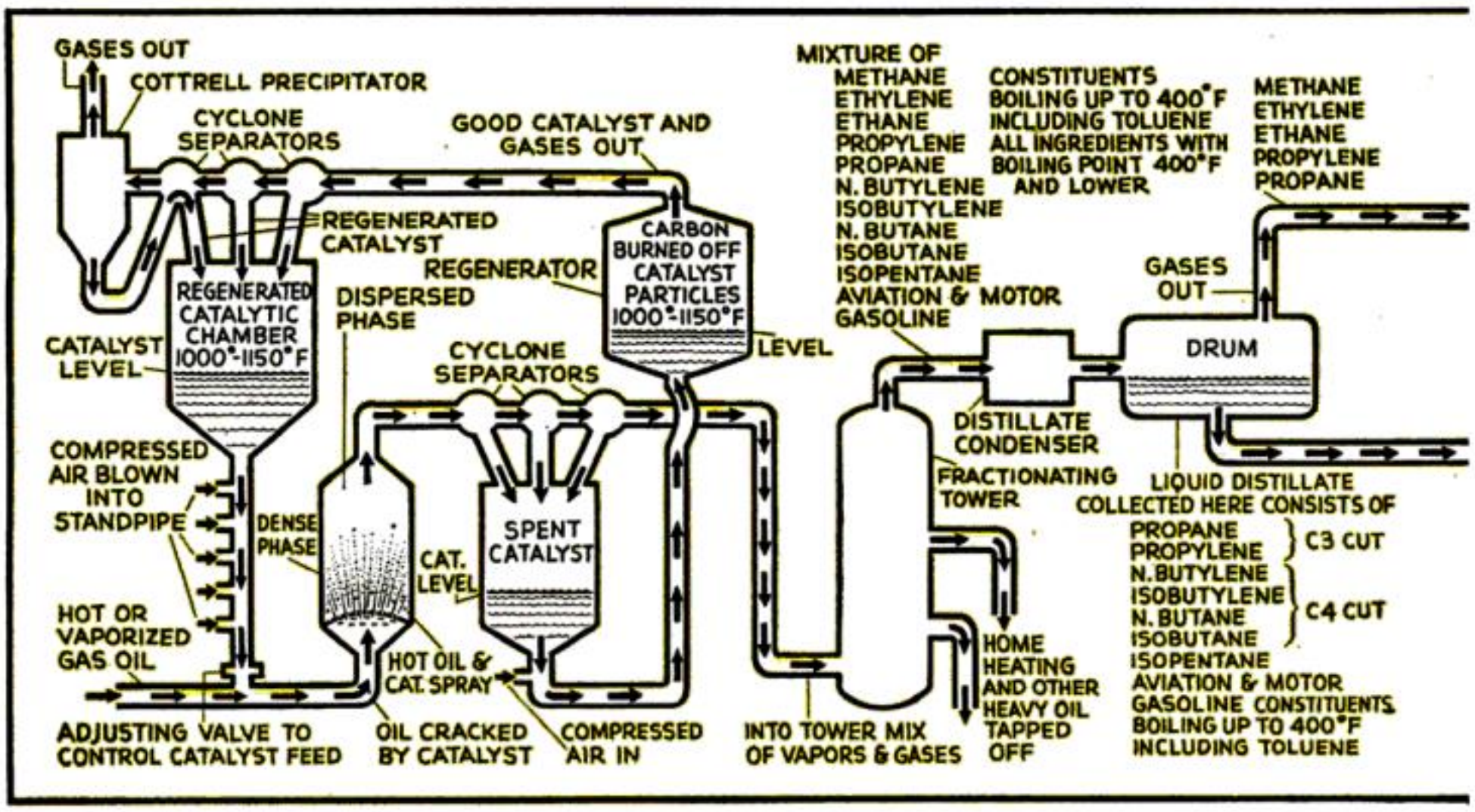
But the explanation is there, deep under the hardpan of Texas and Oklahoma, bubbling up from the hills of Pennsylvania and West Virginia, pumped into great tanks around Lake Maracaibo in Venezuela. The chemistry of World War I was based largely on coal; the chemistry of World War II is based amazingly on petroleum. As surely as our coal, iron, wheat, and copper smashed the Hindenburg Line in 1918, we're going to win *this* war with oil!

Tell that to your neighbor who grumbles because he has to go to bed early to save fuel oil. Tell that to the man who growls when he gets thumbs down from the unhappy attendant of the gas station.

Chemistry is turning oil into hundreds of things that must play their part in winning the war—gasoline and fuel, and also anesthetics for hospitals, formaldehyde for decontamination squads, ethyl alcohol for lacquers, enamels, and varnishes; ethylene glycol to pinch-hit for scarce glycerine in shock absorbers, cigarettes, resins, and soap; and acetone to make cordite, transparent plastic noses for bombers, and tough, opaque plastic grips for Tommy guns.

Oil is our ace in the hole—the handle of a three-pronged pitchfork with which Uncle Sam is planning to chase the Axis off the face of the globe. From oil we are getting three major weapons without which we couldn't even fight, much less win. And those three are going to spell "knockout" in the last round of the fight, because our enemies cannot even begin to match our vast production. They are:

I. *Toluene* that combines with nitric acid to make TNT, the volcanic stuff that fills our four-ton block busters. In World War I we managed to get up to 23,000,000 gallons of toluene a year. In 1939 we made only 25,000,000 gallons. That's about all we could get, the *old way,* making it out of coal tar. But with the *new way*—from petroleum—we could, if we needed to, make one to two *billion* gallons—enough for 10,000,000 tons of TNT.

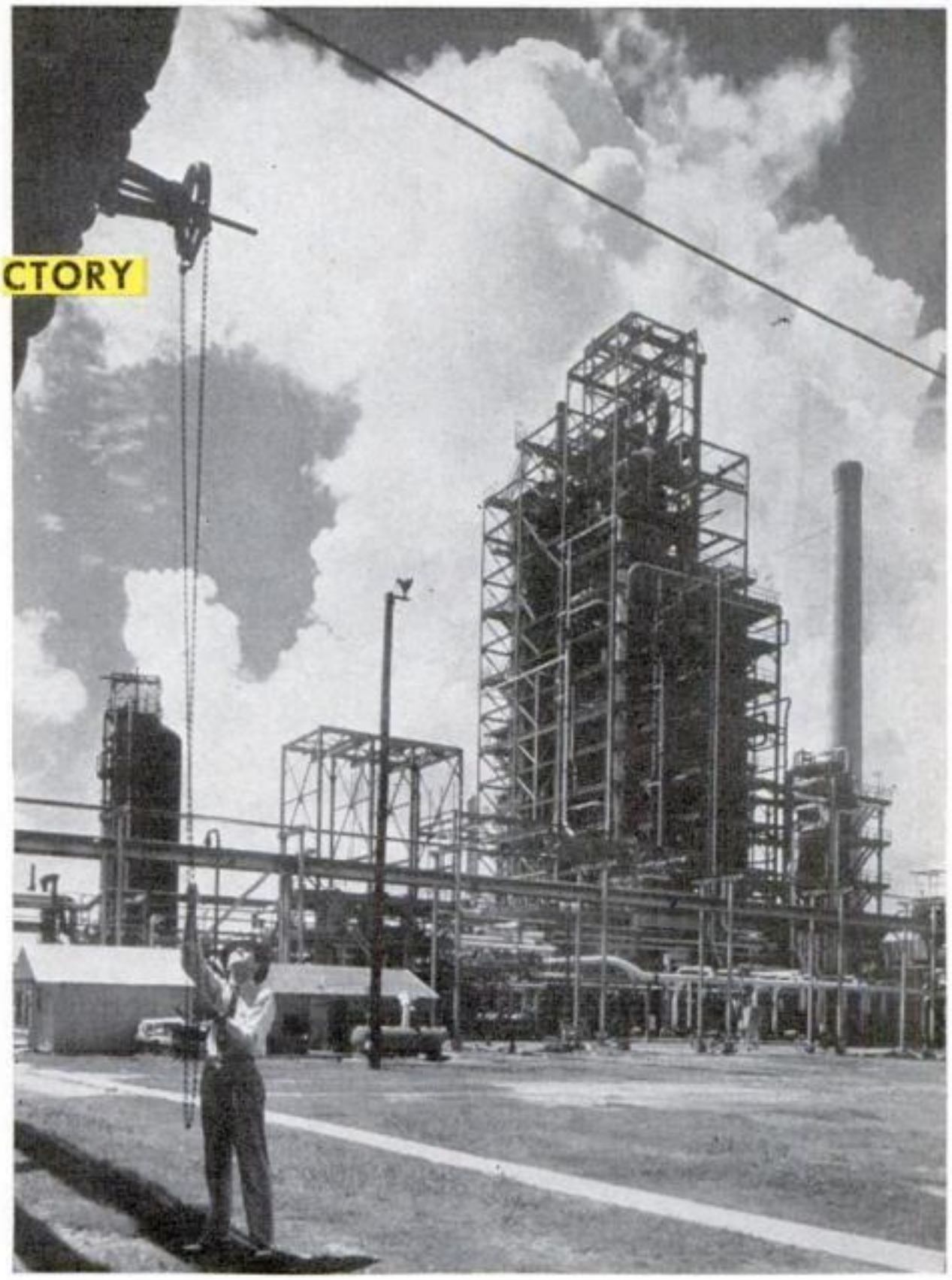


Hole

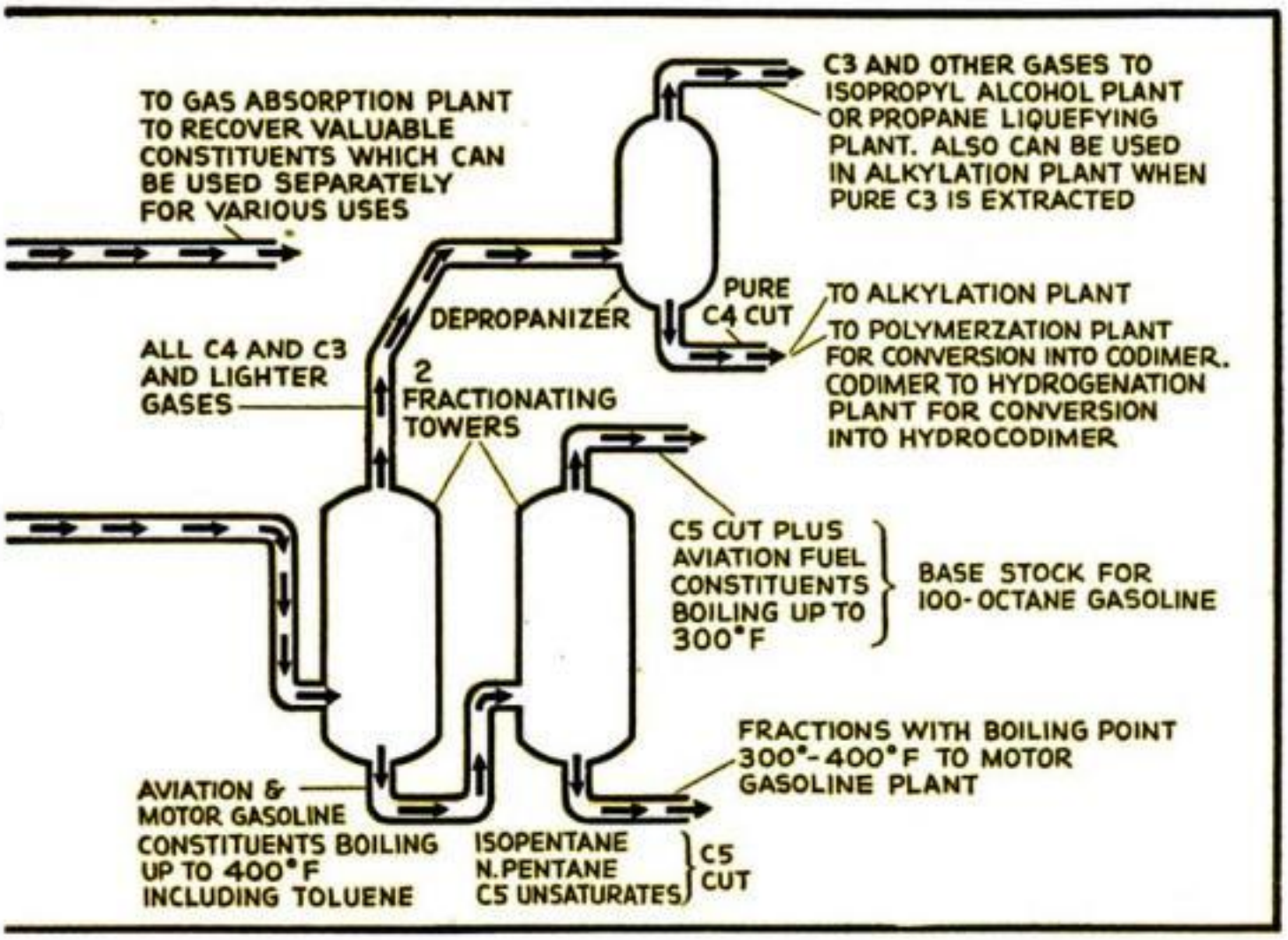
INGREDIENTS OF VICTORY

II. *Rubber* to take the place of natural rubber. Germany may be able to turn out 75,000 tons of synthetic rubber a year. We'll use more than 1,000,000 tons of rubber next year, a third again as much as we ever used before. And 80 percent of it will be made of butadiene, styrene, and isobutylene from oil.

III. *Aviation fuel.* Production figures are secret, but it's safe to say that we are going to use as much 100-octane aviation gasoline this year as we used of ordinary gasoline in 1918. Hitler's chemists don't use our octane scale for rating gasoline. But German aviation gasoline compares in performance with our 91-octane. The difference in our favor is



A catalytic cracking unit at a Standard Oil Company refinery in New Jersey. First of six new plants, it turns out base stock and synthetic blending agents for aviation gasoline



How a continuous "cat cracker" operates is shown in the drawing. The catalyst, helping to break up petroleum hydrocarbons at lower heat and pressure, is regenerated during the oil-cracking process

Nine men facing switches and dials in this central control room are all that are needed to operate a cracking plant as large as a New York skyscraper

about 25 per cent more power at the take-off, an edge of 1,500 feet in ceiling, and a saving in mileage that means our planes can carry less fuel, more bombs. Before the gong rings for the last round, we'll be using gasoline far above 100 octane.

Petroleum chemistry is opening up still newer uses for oil. Even the natural gas that rushes from newly drilled wells is being put to new use. It once was allowed to escape or to burn off, and some was piped for household use or in heating plants.

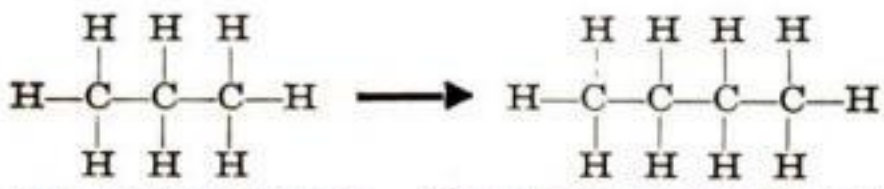
But this natural gas contains many of the same hydrocarbons—methane, ethane, propane, and butane among others—that are found in crude petroleum. Even waste gases that find their way into oil pipe lines are reclaimed by one company to make ethyl alcohol—exactly like the grain-fermented alcohol in whisky! Of the butadiene that the petroleum industry pours into the synthetic-rubber program, about one gallon in ten will come from normal butane extracted from natural gas. Plants are now going up to turn natural gas into acetylene for welding the great prefabricated sections that are breaking all speed records for the building of cargo ships. Late news in the petroleum world is the discovery of a new explosive—said to be even better than TNT—to be made from natural gas!

The public began to get a glimpse of the vast world concealed in a barrel of oil when the rubber scare began to boil over in newspaper headlines. When Dr. Per Frohlich of the Standard Oil Development Company actually *made rubber* in a test tube before a group of astonished Congressmen, he put them in a mood to expect miracles. They will not be disappointed.

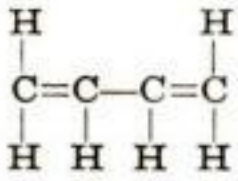
Oil isn't a simple substance. It is a mixture of *compounds*. Some natural oils contain only a few of these compounds; some contain thousands. The substances that make up these compounds range all the way from methane ($C\ H_4$), an extremely light gas, to hexacontane ($C_{60}\ H_{122}$), hard and heavy as a lump of anthracite. These substances are grouped into series, such as paraffins, olefins, naphthenes, and "aromatics." Hard or soft, gas, liquid, or solid, the heavier ones will all dissolve in the lighter ones and form a compound. Furthermore, all the substances in oil are hydrocarbons; that is to say, they are made up of carbon and hydrogen, the "building blocks" of organic chemistry.

The oil chemist's business is to take these blocks apart and put them together into different shapes, sizes, and weights until he gets a molecule that has just the characteristics he wants. Perhaps he starts with propane gas and comes out with isopropyl alcohol, a handy antiseptic when grain alcohol is hard to get.

Or he might take that same propane gas and tack on another carbon atom with its full complement of hydrogen atoms:



and he has butane. By "dehydrogenating," that is, knocking off a couple of pairs of hydrogen atoms, he gets



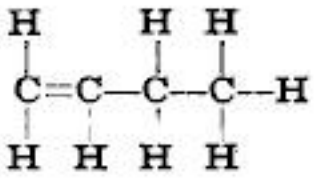
which is butadiene. He is already well on

SOME OF THE PRODUCTS DERIVED FROM PETROLEUM

Primary Distillates	Fractionation Products	Acid Treating, Cracking, Re-running, Solvent Extraction, De-Waxing Products	Hydrogenation, Dehydrogenation, Polymerization, & Miscellaneous Treating Products	Product Uses
PETROLEUM				
Hydrocarbon Gases	Uncondensable Gases	Hydrogen		
	Liquefied Gases Petroleum Ether			Metal Cutting, Cooking-Illuminating Gas
	Polymers	Olefins	Anti-knock Fuels, Alcohols Synthetic Lube Oils, Esters Ketones, Synthetic Rubbers Lube Oil Additives, Synthetic Plastic Waxes	Antifreezes
		Diolefins	Synthetic Rubber, Resins	
	Gas Black			Rubber Tires, Inks, Paints
	Fuel Gas			
	Naphthas	Light Naphthas		Gas Machine Gasoline
		Intermediate Naphthas	Aviation Gasoline Motor Gasoline	
			Commercial Solvents	Rubber & Fatty Oil Solvent, Lacquer Dil
			Toluene	Explosives
Light Distillates	Refined Oils	Heavy Naphthas		Varnish Makers, Painters, Dyers & Cleaners, Naphthas & Turpentine Substitutes
		Refined Kerosene		Stove, Lamp, & Tractor Fuels Railroad Signals, Lighthouse Oil, Ship Illuminants, Gas Absorption Oils
			Lube Oil Additives	
Intermediate Distillates	Gas Oil	Naphthenic Acids		Water Gas Carburation Oils Metallurgical Fuels Heating Fuels, Diesel Fuels
	Absorber Oil			Gasoline Recovery Oils Benzol Recovery Oils
Heavy Distillates	Technical Oils	White Oils (Technical)		Insecticide Sprays, Tree Spray Bakers, Fruit Packers, Candy Makers Egg Packers, & Slab Oils
		White Oils (Medicinal) Recoil Oils Hydraulic Oils		Internal Lubricants, Salves Creams & Ointments
	Lube Distillates	Saturating Oils		Wool, Leather & Twine Oils
		Emulsifying Oils		Cutting, Textile, Paper & Leather Oils
		Flotation Oils		Metal Recovery Oils
		Paraffin Wax		Candy Makers, Chewing Gum Candle, Laundry, Sealing, Etchers Saturating, Insulating, Match Cardboard, Paper, Medicinal & Canning Waxes
			Paraflow	Lube Oil Pour Depressant
			Fatty Acids	Grease & Soap Lubricant
			Fatty Alcohols & Sulphates	Rubber Compounding Detergents & Wetting Agents
	Lubricating Oils	Light		Turbine, Light Spindle, Transformer Household Lubricating, Compressor Ice Machine, Meter, Dust & Tempering Oil
		Medium		Journal, Motor, Diesel, Engine & Railroad O
Residues	Lube Residuum	Heavy		Steam Cylinder, Valve Transmission, Printing, Black Oils & Lubricating Greases
		Medicinal Petrolatums		Salves, Creams, Ointments & Petroleum Jell
		Technical Petrolatums		Rust-Preventing Compounds Lubricants & Cable Coating Compounds
	Residual Fuel Oils			Wood Preservative, Boiler Fuel Gas-Manufacture Oils & Metallurgical Oi
	Asphalts	Still Wax		Roofing & Shoe Material
		Liquid Asphalts Binders Fluxes		Roofing Saturants, Road Oils & Emulsion Bases
		Steam Reduced Asphalts		Briquetting & Paving Asphalts Shingle Saturants, Paint Bases Flooring Saturants
		Oxidized Asphalts		Roof Coatings, Waterproofings Rubber Substitutes & Insulating Asphalts
	Coke			Carbon Electrodes, Carbon Brush Fuel Coke
	Refinery Sludges	Acid Coke		Fuel
		Sulfonic Acid		Saponification Agents Fat-Splitting Agents, Special Oils Demulsifying Agents, Emulsifiers
		Heavy Fuel Oils		Refinery Fuel

POPULAR SCIENCE MONTHLY

the way to making synthetic rubber. Or he can knock off only one pair of hydrogens and come out with butylene:



From this he can go ahead and make secondary butyl alcohol and then methyl ethyl ketone, an important solvent for tough, weather-resistant coatings like Koroseal. The chemist can start almost anywhere among the thousand or so different hydrocarbons in a batch of oil, set out in almost any direction, and arrive at something pretty important. Paths will cross and recross, for there usually are several different ways of getting to the same point, but there is practically no limit—and this is no mere figure of speech—to what can be made with the building blocks in a barrel of crude petroleum. Medicines, plastics, "silk" stockings, self-sealing "rubber" fuel tanks, adhesives, finishes, fuels, and many other things made of those blocks will touch your life in scores of places every day in years to come.

Cracking is the principal way of breaking up petroleum molecules. You can "crack hard" with a lot of heat and pressure or "crack lightly" with less. The distillates are not allowed to boil off. Instead, the pressure is allowed to build up as high as 1,000 pounds per square inch.

Under terrific heat and pressure, kerosene, paraffin, and heavier oils are "cracked" into gasoline. Or they may even be "cracked hard" into propane, butane, or ethane gas.

But in cracking, light hydrocarbons also tend to combine into heavy ones. At temperatures above 1,100 degrees Fahrenheit, propane and butane molecules begin to join forces and turn into benzene and toluene —heavy "aromatic" substances. So cracking—regular thermal cracking at least—tends to work both ways at once.

Hydrogenation is the business of shooting some free hydrogen into a still while the "feed stock" is under heat and pressure. Petroleum engineers use it when they want to get the maximum amount of gasoline out of a batch of crude.

If you'll look at the formulas of petroleum hydrocarbons from C H_4 (methane) to C_{60} H_{122} (hexacontane), you'll notice that the light ones have a larger proportion of hydrogen than the heavy ones. In fact, the lighter the "fraction," the higher the proportion of hydrogen to carbon.

So the introduction of free hydrogen, at the moment when the heavy hydrocarbons are hot and jittery and ready to break down, causes them to take on more hydrogen. The more hydrogen they take on, the lighter they become until even the dense, heavy asphalt in the oil turns into a heady gas like ethane. That explains why—though crude oil is seldom more than 40 percent gasoline—you can feed 100,000 barrels of crude into a hydrogenating still and actually get out of it 110,000 barrels of gasoline!

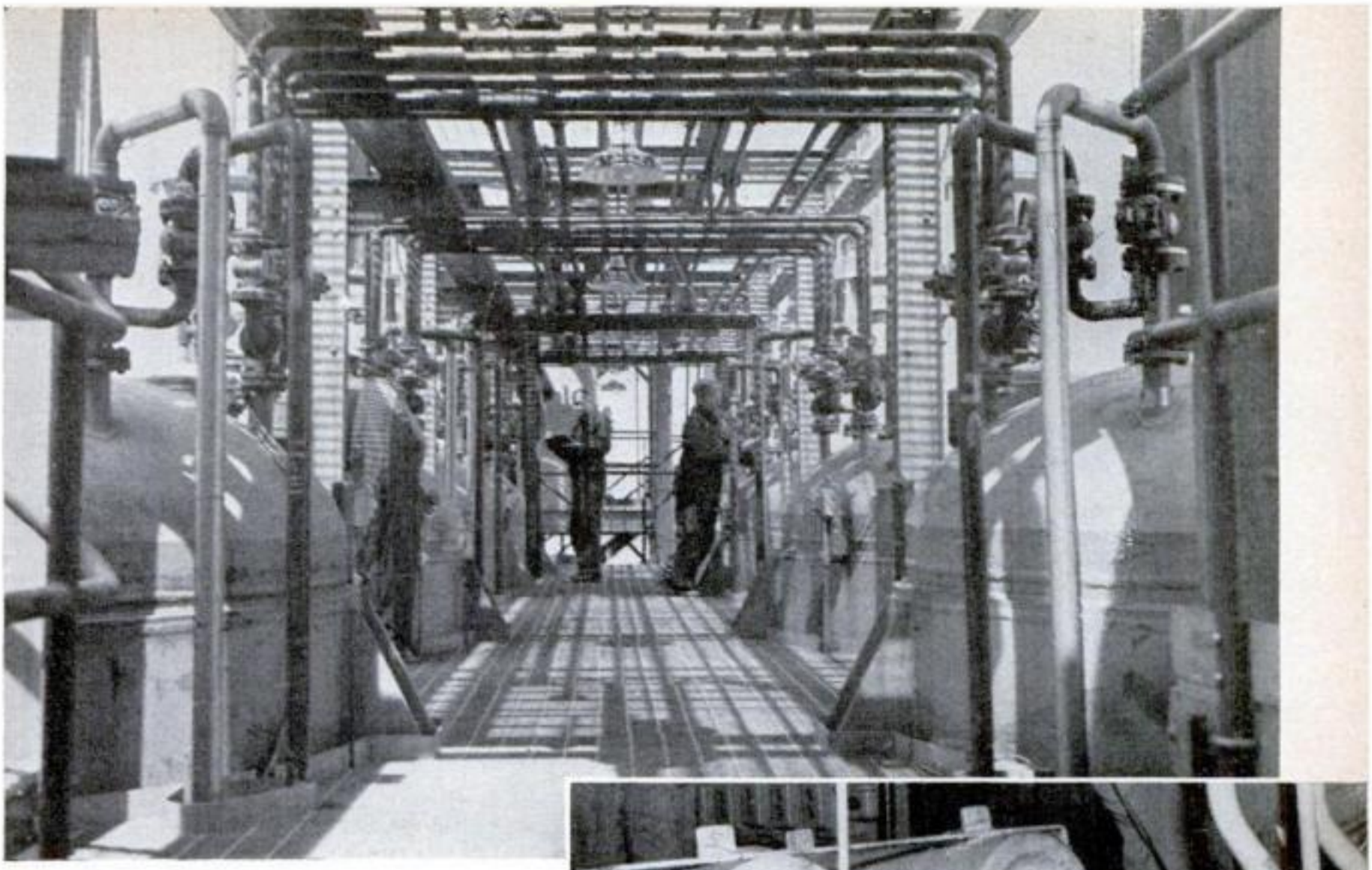
Polymerization is the petroleum chemist's way of forcing unsaturated light substances to combine into heavier ones. It is usually done with the aid of a catalyst—some chemical introduced to cause a reaction without becoming a part of the new compound. Catalysts are rapidly becoming the traffic policemen of modern organic chemistry. And where thousands of molecules are rushing around, trying to sort themselves, some pretty complicated traffic jams are likely to occur. So many of the molecules are so much alike, it's pretty nearly impossible to keep them from getting mixed up.

Temperature and pressure have to be rigidly controlled. A batch of crude is run into a still and cracked. When it's run off the various compounds are still intermingled. The mixture is then run into a regular "fractionating tower," or simple still.

In the simple still the mixture is separated into its various parts. Some of these parts, or "fractions," may be finished products like benzine or kerosene, some may be base stock for gasoline, and some may be "intermediates" like, for instance, isobutylene, which the chemist may want to polymerize and hydrogenate *again* to turn it into iso-octane. Iso-octane can be used with base stock, tetraethyl lead, and perhaps some other things to make 100-octane gasoline. Thus the "intermediate" will have to be processed at least once more.

Catalytic Cracking. To get the last drop of precious product out of a batch of crude oil, chemists need the last word in temperature and pressure control. In big plants running up to 300,000 barrels of crude a day under terrific heats and pressures, such close control used to be almost impossible, so great quantities of refinery gases—potential rubber, 100-octane gasoline, and even explosives—were apt to burn up and be wasted.

But for three or four years before Pearl Harbor, the chemists had been performing miracles of hairline control in labs and pilot plants by injecting catalysts into their cracking stills. Catalysts take the place of heat and pressure in breaking down petroleum hydrocarbons. Sometimes the catalysts are synthetic chemicals made to rigid specifications; often they are simple alumina or silicates of common back-yard clays!



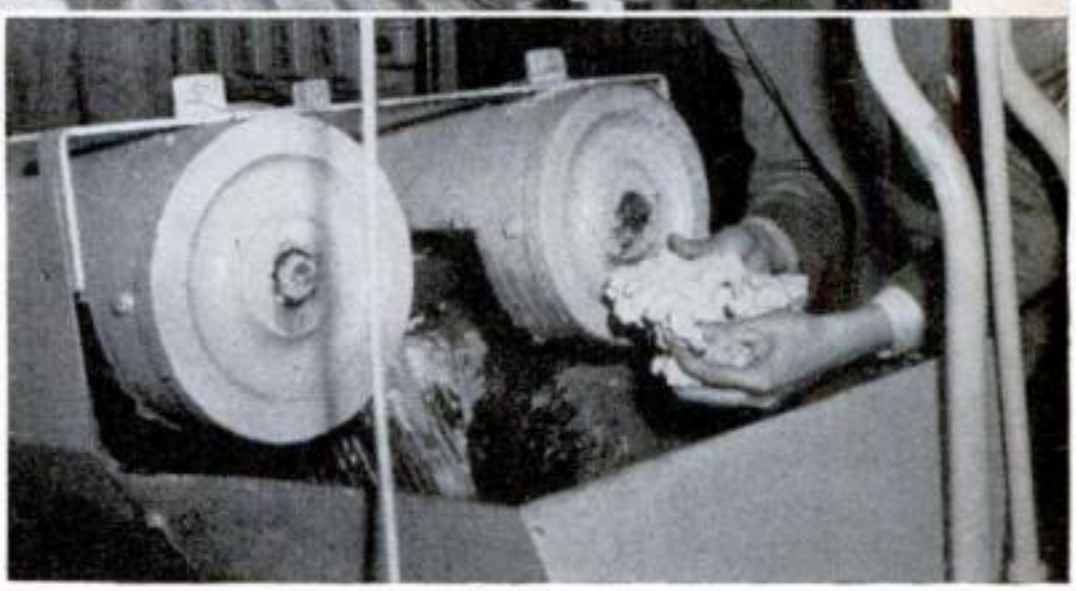
Dome-shaped polymerization units for making synthetic-rubber latex as seen from a catwalk in one of the plants. Here synthetic rubber is manufactured from butadiene, a product of petroleum

The operation can be controlled much better if a still can be run at comparatively low temperatures. And this can be done with catalysts. Then too, catalysts can be varied to get exactly the reaction wanted.

When war skyrocketed the demand for 100-octane gasoline and scores of chemicals not easy to get out of petroleum with ordinary equipment, the catalysis experts were called in. There was a second good reason for this.

Big cracking stills built to withstand terriffic heat and pressure would call for tremendous amounts of steel and other vital war metals. Catalytic stills could be lighter, and would require far less metal.

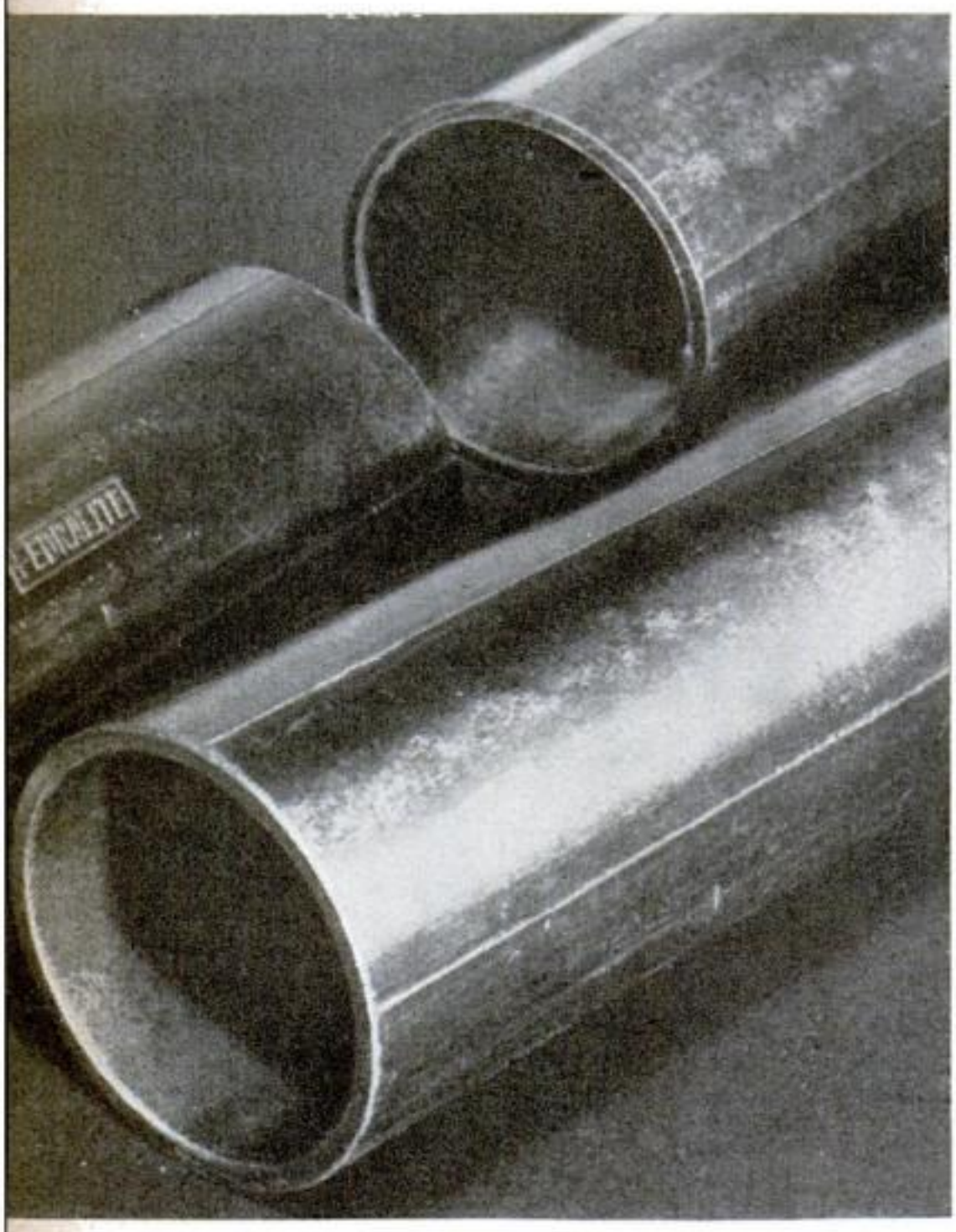
But putting "cat cracking" on a mass-production scale was a ticklish engineering problem. As cracking takes place, the catalyst itself tends to run down. As the hydrocarbon molecules rush and tumble about, some of them join together into heavy particles of *coke*. Cracking 10,000 barrels will produce as much as 120 tons of this black, tarry *(Continued on page 204)*



In the coagulating process, the liquid synthetic latex is piped from blending tanks, united with a coagulant, and sent to a disintegrator to break up into pellets for drying

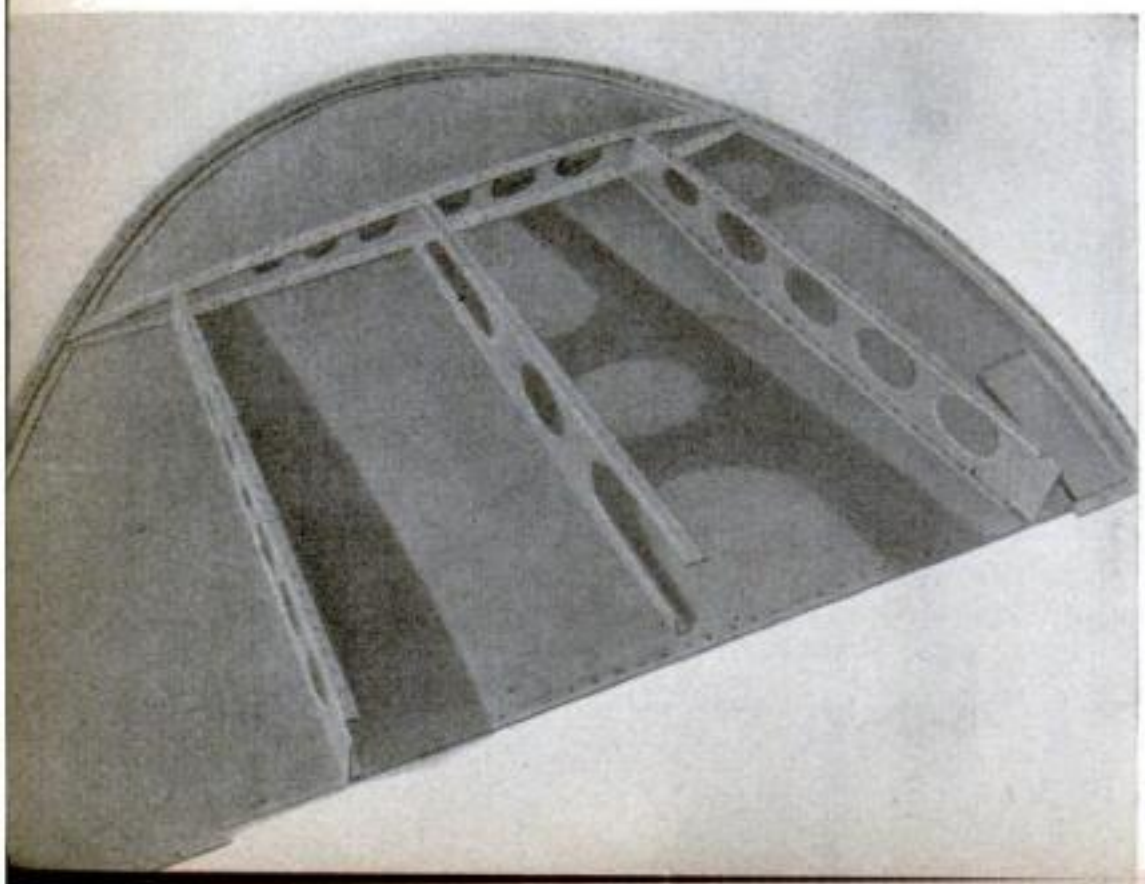
A mill mixes the rubber with various chemicals that aid in vulcanization and add toughness. Rolls on the mixing mill promote a masticating action that makes the rubber plastic

New Jobs for Paper...



Made of resin-treated paper that weighs less than a pound per square foot, tubing manufactured by the Federal Electric Co. is replacing steel in low-pressure oil pipe lines

Paper wing tips for planes are lighter and stronger than aluminum, have a smooth surface that requires no finishing



McDonell Aircraft Corp

PAPER has turned out to be the "dark horse" in the industrial race to find substitutes. Under the stimulation of war demands, it has braced itself to do much of the rugged civilian work formerly performed only by steel, cast iron, and aluminum, and to release those materials to the more important job of winning the war. Perhaps the most spectacular bit of pinch-hitting it has done to date is in substituting for the tin oil can. Treated with compounds derived from corn and other farm products, the new paper container is thoroughly oil-resistant and durable beyond belief. A blowtorch flame that will eat through a tin container in three seconds takes as many as 50 seconds to cut its way through the paper container. The amount of metal the substitution of paper is saving in the petroleum industry alone is estimated at 135,000 tons a year, and representatives are already declaring that as far as they are concerned the new containers are here to stay.

In one notable instance paper has not been content to play second fiddle, but has itself become a war product—as wing tips for airplanes. Impregnated with phenol formaldehyde and molded in a hydraulic press, paper wing tips have proved lighter and stronger than aluminum, less susceptible to dents and abrasions, and easier to design.

It is in the home, however, that paper has most substantially come into its own. In garbage cans it is replacing the galvanized steel formerly used. In kitchen stoves it is replacing the backs and sides to a point where construction of the average stove now requires less than 100 pounds of metal. Sturdy paper shoe trees that can be folded flat for packing are taking the place of those formerly made of steel. And as tubing for toothpaste and shaving cream, and as compacts and containers for lipstick, paper has found two more of the many roles that it seems destined to play even after the curtain comes down on the present war.

POPULAR SCIENCE

IT REPLACES MANY WAR-NEEDED MATERIAL

IRON AND STEEL

TOOTHPOWDER CONTAINERS

PIPE

TOBACCO TINS

OIL CANS

OTHER METALS

ASHTRAYS (COPPER)

COLLAPSIBLE TUBES (TIN)

AIRPLANE PARTS (ALUMINUM)

LIPSTICK CONTAINERS (BRASS)

NON-METALS

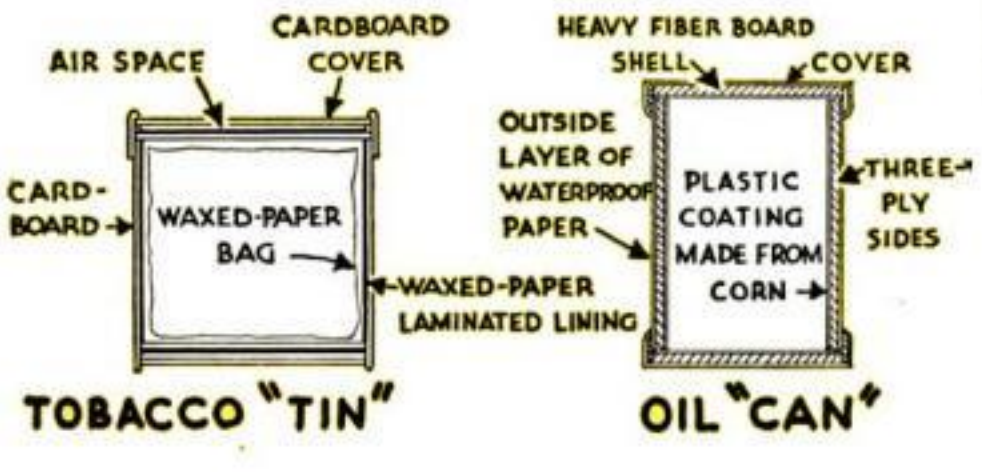
GASKETS (RUBBER)

UNDERWEAR (WOOL)

SHOPPING BAGS (MANILA CORD)

INNER SOLES (RUBBER, CORK)

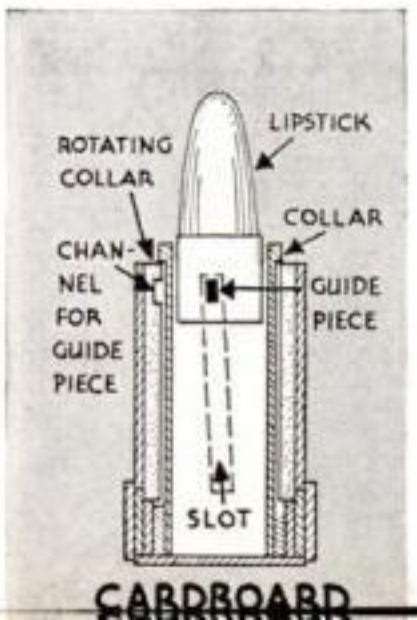
In place of burlap, which can no longer be imported, water-resistant Aqualized paper is being used for the shipping of moisture-secreting vegetables. Because of a special processing, the fibers of Aqualized paper actually get stronger when they are soaked



Tobacco stays just as fresh in its new cardboard packaging as it did when it was put up in tins. For motor oils, a "can" made of paper which is treated with compounds derived primarily from corn has been developed to form a leak-proof and extremely durable container

A boon to housewives is the new paper baking receptacle which will not burn, leak, or break—and best of all is sufficiently inexpensive that it can be thrown away after being used only once

As a substitute, paper has made itself valuable to the cosmetics industry in the form of compacts and lipstick containers. In both appearance and shape it is the equal of prewar metal containers



MEN of the U. S. Navy's Armed Guard aim a four-inch 50 at a submarine from the icy afterdeck of a cargo ship. The trainer, seated at the right, swings the gun horizontally; pointer, opposite, gets elevation

Can we break the U-boat strangle hold?
Here's how the Navy's Armed Guard is

Getting the Convoys

By BERNARD WOLFE

Photographs by ROBERT F. SMITH

FOR eight days and nights, the Focke-Wulf Condors have been circling the convoy, hovering in the horizon clouds tantalizingly beyond gunshot. Their mission is reconnaissance, and they have the patience of vultures waiting for the kill. Sooner or later, attack planes are bound to show up, but no one knows when. The men who man the guns on the merchant vessels can do nothing but stand by and wait, taking turns on lookout, while their ships plough deeper into the Barents Sea.

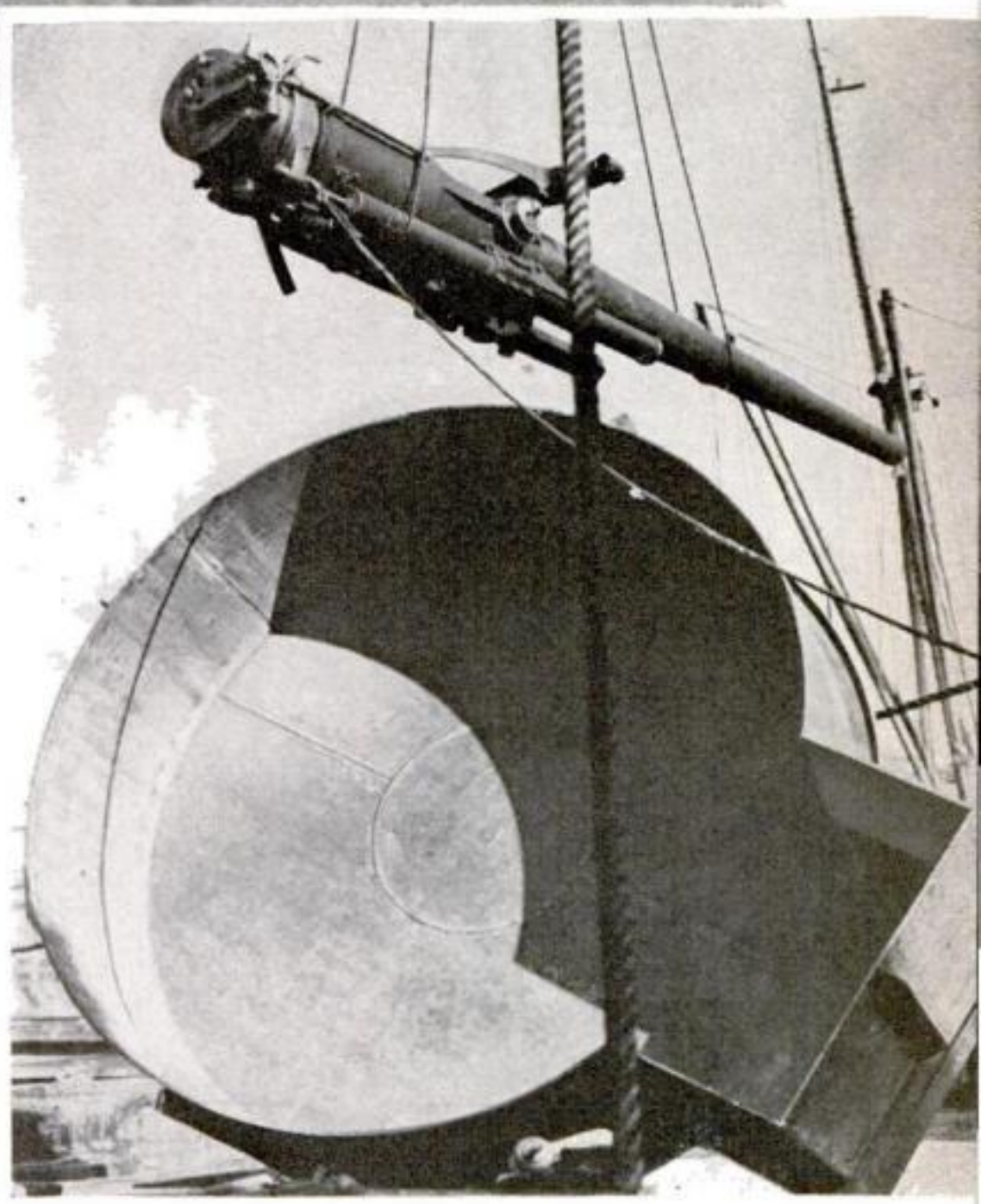
On the ninth day, when nerves are frayed to the snapping point, new signal hoists flutter up on the Commodore's halyards. The time for action has come. This is it!

On scores of battered merchantmen, strung out in columns that stretch from horizon to horizon, the shattering bells of the "general alarm" sound off. Men bolt from their quarters and sprint for their battle stations, lugging their life jackets with them as they race along gangways and catwalks. In groups of three they scramble up elevated turrets forward, aft, and amidships, to man the machine guns. Larger crews of eight or ten reach the big guns and break out the heavy ammunition.

Even before the attack planes sweep into sight, dual-purpose guns are blazing away on mine sweepers, flak ships, and cruisers down along the center of the convoy, heaving salvos up at them. A moment later they

U. S. Navy Photos

GUNS range from .30 caliber machine guns up to five-inch dual-purpose jobs used for either surface or antiaircraft work. This is the 20-millimeter Oerlikon, the favorite weapon of the Armed Guard men against bombing planes. Man at right holds a loaded magazine



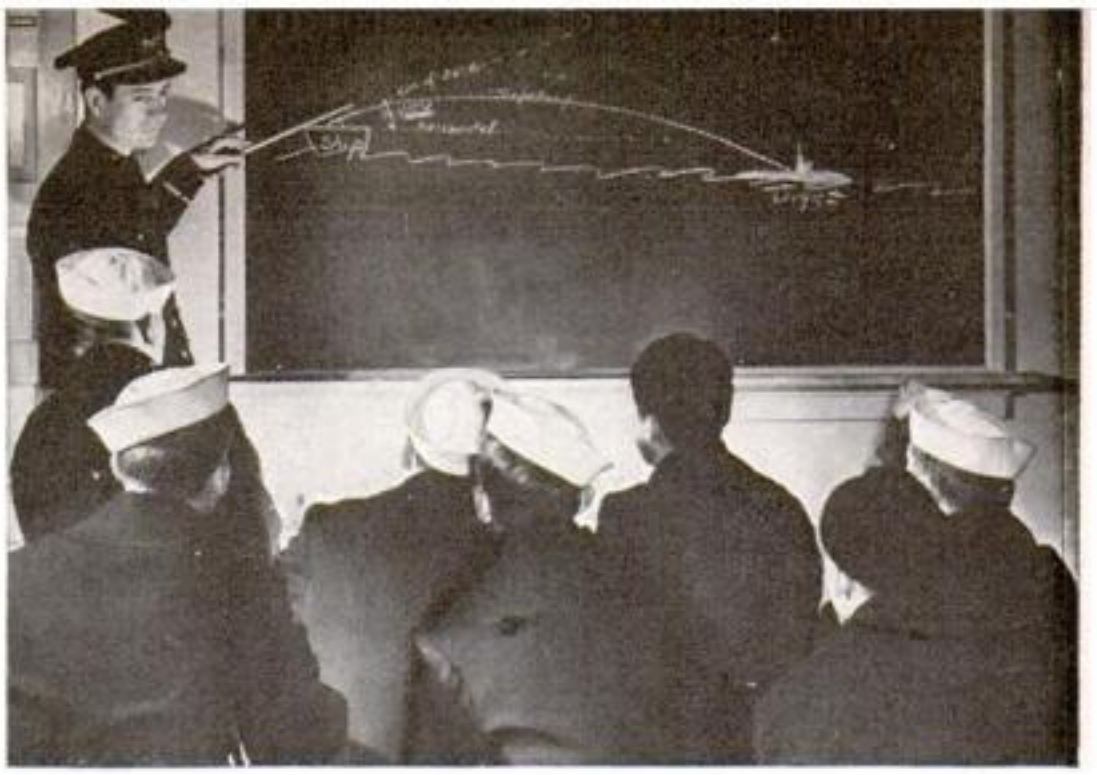
ARMOR takes the form of a circular steel shrapnel shield designed to protect the gun crew against flying bomb fragments or steel torn from their own vessel. At right are a gun and shield ready for mounting on a ship

Through

crystallize out of the alto-cumulus, endless wedge-shaped squadrons of them, winging straight in from the Norwegian fiords. There are over a hundred planes all told — Messerschmitt 110's, Heinkel 111 K's loaded with torpedoes, dive-bombing Stukas, Junkers 89's. In a minute all hell breaks loose as the bombers peel off one after another, climbing down the stairs to deposit their lethal eggs on the ships of the convoy. . . .

This scene was only the curtain-raiser of a running fight that was to keep up for many sleepless days on end, straight across the Arctic waters to the Northern Cape, then down into the Kola Inlet and right through to Murmansk. But the crews on those cargo ships stuck by their guns—some of them perched atop 500 or more tons of TNT, knowing that one near miss would blow them all to Kingdom Come. Time and again, pink-glowing tracers from their 20-millimeters arched up into the blinking fire of a Messerschmitt or Stuka, and the plane streaked flaming into the sea. One of their four-inch 50's, firing point-blank at a conning tower spotted right in

At receiving centers, the Armed Guardsmen are taught to identify some 50 types of friendly and enemy aircraft. Instruction is by means of models, as above, and by special training films



Their brief training period doesn't allow time for any deep study of ballistics, but they learn enough about the theory of gunnery to understand shell trajectories and know what happens when they take a shot at a U-boat

CLASSROOM DRILL PREPARES GUN CREWS FOR THEIR JOB . . .

Split-second co-ordination that makes teamwork in a gun crew is acquired by constant drill at a loading breech built for training purposes, while the men wait to be assigned to a ship

Here they are learning to handle the Oerlikon. Three men man this gun, the gunner strapped to the shoulder rests and leaning back with his feet planted far apart. The spring coiled around the barrel is part of the recoil mechanism

the heart of the convoy, scored a direct hit, and all that was left of the sub was a bubbling froth and a spreading oil slick. An enemy destroyer, foolhardy enough to dart in close, was blown sky-high, while a sister ship limped off ablaze.

Ships were lost, and men too, but—thanks largely to these gunners—the greater part of the convoy got through to Murmansk port with its trucks and planes and dynamite. The escort cruisers and corvettes did a magnificient job, but in the last analysis it's every merchantmen for himself in these running battles, and without their gun crews very few of the cargo ships would have made it.

Known to the Navy as the Armed Guard, these men at the guns are an amazing lot. For all their air of seasoned veterans, most of them on that convoy were out at sea

for the first time in their lives. Only a few months before, they had been ordinary youngsters of 17 or 18, passing their time in classrooms, on farms, and in shops or factories. Since the war started, they and their mates have taken all the enemy had to offer, not only on the harrowing Murmansk run, but through the Mediterranean to bomb-pocked Malta, along the Atlantic routes, and out across the Pacific. Whenever American supplies are shipped out, the Armed Guard is to be found aboard, oiling the guns and standing by on the lookout for trouble.

The Armed Guard is something new in our fighting forces. Organized in the summer of 1941, its job was, as the Navy saw it, to handle the guns that, sooner or later, would have to be installed on merchant ships to get lend-lease materials safely to their destinations. But it wasn't until November 18, 1941, when the President signed the Repeal of the Neutrality Act, that cargo ships began to be fitted out with guns.

Today, there are thousands of men and officers in this unique service. What distinguishes them, besides their extreme youth, is the circumstance that they are trained and rushed into their active duty faster than any other branch of the armed forces. These men, like all newcomers to the Navy, must first spend one month at Boot Camp, getting their indoctrination and

WHEN THEY WILL SWING INTO ACTION AGAINST THE AXIS

1 When an enemy submarine, plane, or surface vessel is sighted, one of the men on watch sets off the "general alarm," ringing bells in all parts of the ship

2 Wherever they are, men grab their kapok life jackets and race for their battle stations. They must be at their posts in 30 seconds

3 The 10-man crew of the big gun strips off the canvas cover and readies the piece for action. Loaders take their posts to pass ammunition from the ready box

4 When the gun captain opens the breech and commands "Load!" a loader rams a shell home. Trainer and pointer get to work

learning what it's all about. When they volunteer or are assigned to the Armed Guard, they are packed off to Little Creek, Va., Gulfport, Miss., or San Diego, for some three weeks of basic training in seamanship and gunnery at an Armed Guard school. Here they are assigned to gun crews, under the command of an ensign or lieutenant (junior grade), and then sent on to one of the three Armed Guard centers, located in New Orleans, San Francisco, or New York. While waiting for assignment to a ship, the crews get further training.

Their brief training period is jam-packed with vital instruction. Since their primary job will be to sink enemy subs, planes, and surface vessels, the emphasis is on practical gunnery, and the men are put through their paces with loading drills and intensive firing practice on a variety of guns. Through it all, their instructors aim at turning out a highly flexible team, for the duties of each crew will depend on the far-from-uniform armament found on board merchant vessels. Although the 20-millimeter Oerlikon is coming into widespread use on cargo ships, there are still many .50 caliber Browning and .30 caliber Lewis machine guns in use, and the men must be able to handle all of them. In the big-gun field, the major calibers found on merchant ships include the three-inch 50 (dual purpose), the four-inch 50, the five-inch 50, the five-inch 51, and the new five-inch 38 (dual purpose), as well as the three-inch 23 and the six-pounder. Armed Guard men must know how to man these too. (The numbers following the bore size is the ratio of barrel length to bore diameter. A three-inch 50, for example, has a 150-inch barrel.)

On board ship, the Armed Guard members have their own sleeping quarters and often their own mess quarters as well. They maintain friendly relations with the merchant crew, but are responsible only to their commanding officer, who is military adviser to the skipper. The men maintain a continuous rotating lookout, independently of the merchant crew. In the event of torpedoing, their instructions are to stand by their guns to the last. As long as a target is in sight, they must maintain fire until their gun is awash.

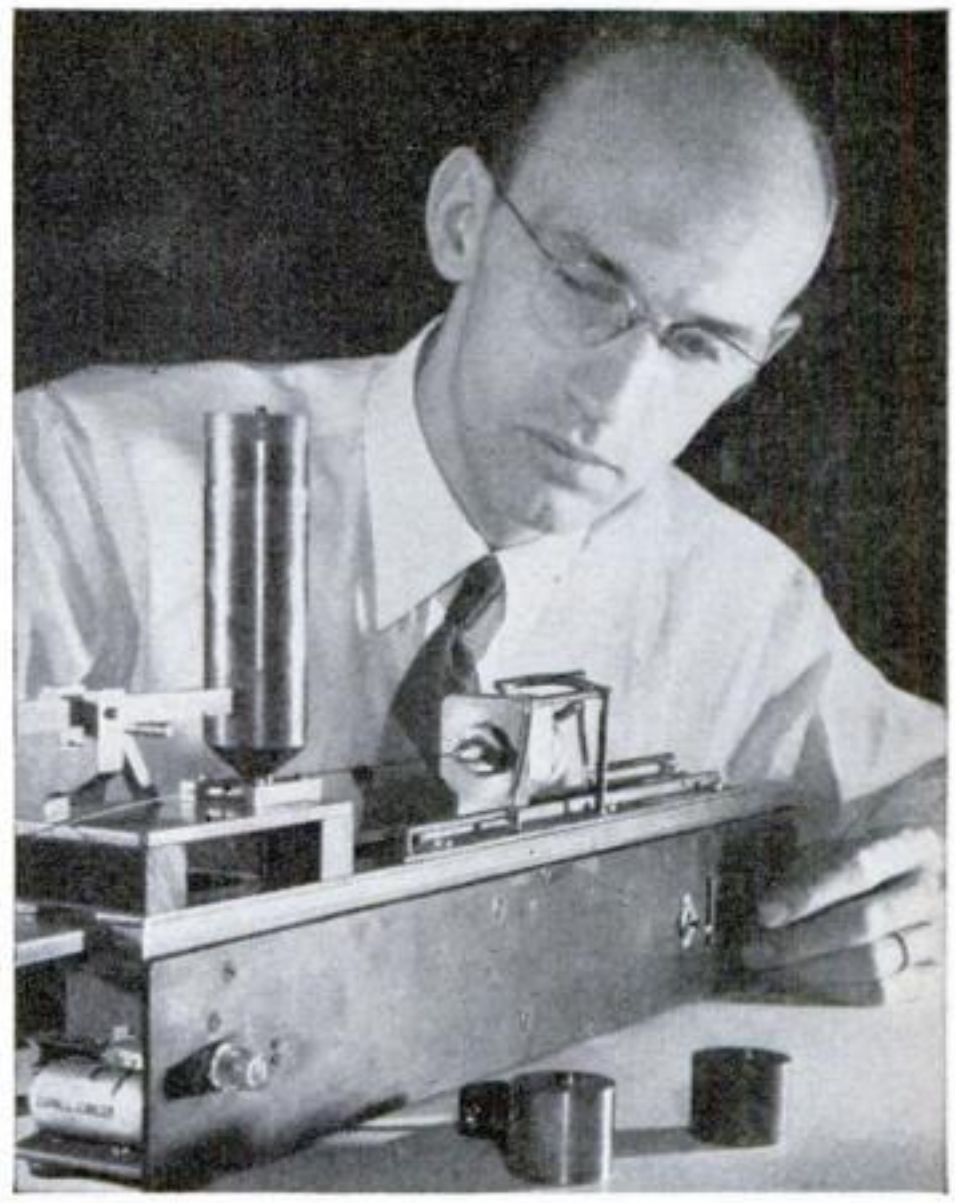
Such are their instructions, but some crews have preferred to stand valiantly by their guns to the very end, even when the attacking sub was nowhere in sight. Bitter experience has taught these men that often, after a torpedoing, undersea wolves will surface to shell the lifeboats, and they have been ready to gamble their lives for at least one crack at the enemy. "U. S. Navy gun-crew members were the last to leave the ship," reads the laconic report of the master of a cargo ship that had been torpedoed; only one out of nine was saved. Another crew had its big gun knocked out of action by a direct hit, but it remained to man the smaller guns until water was knee-deep on the main deck. Crews like these have bagged more than one reckless undersea raider which came up too soon.

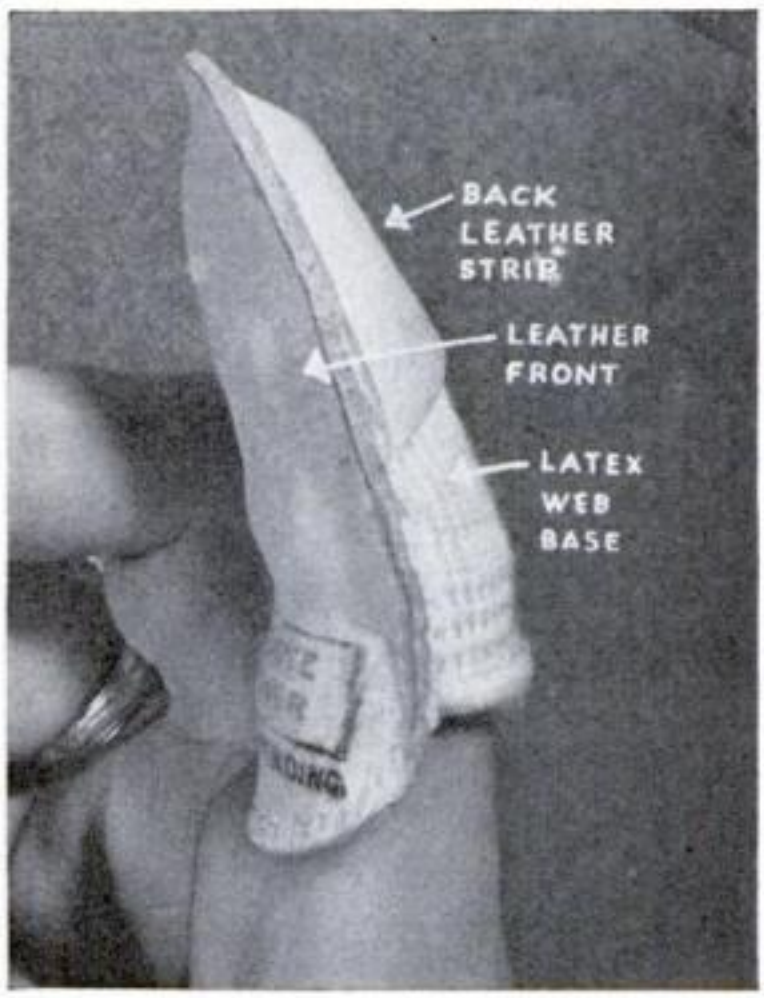
They are tough, these lads of the Armed Guard. Torpedoed, having seen their shipmates go down beside them, adrift in Arctic or tropical waters for days and weeks on end, they keep coming back for more. In the words of a Navy commentator, they have only one thing on their minds—"to keep the paths overseas open and Davy Jones's locker shut."

MERCHANT SEAMEN LEARN GUNNERY IN THIS CLASSROOM ON WHEELS

For training merchant seamen as gunners, the Armed Guard operates busses which visit piers in seaport areas. Above, sailors get instruction in use of .30 caliber machine gun and Oerlikon

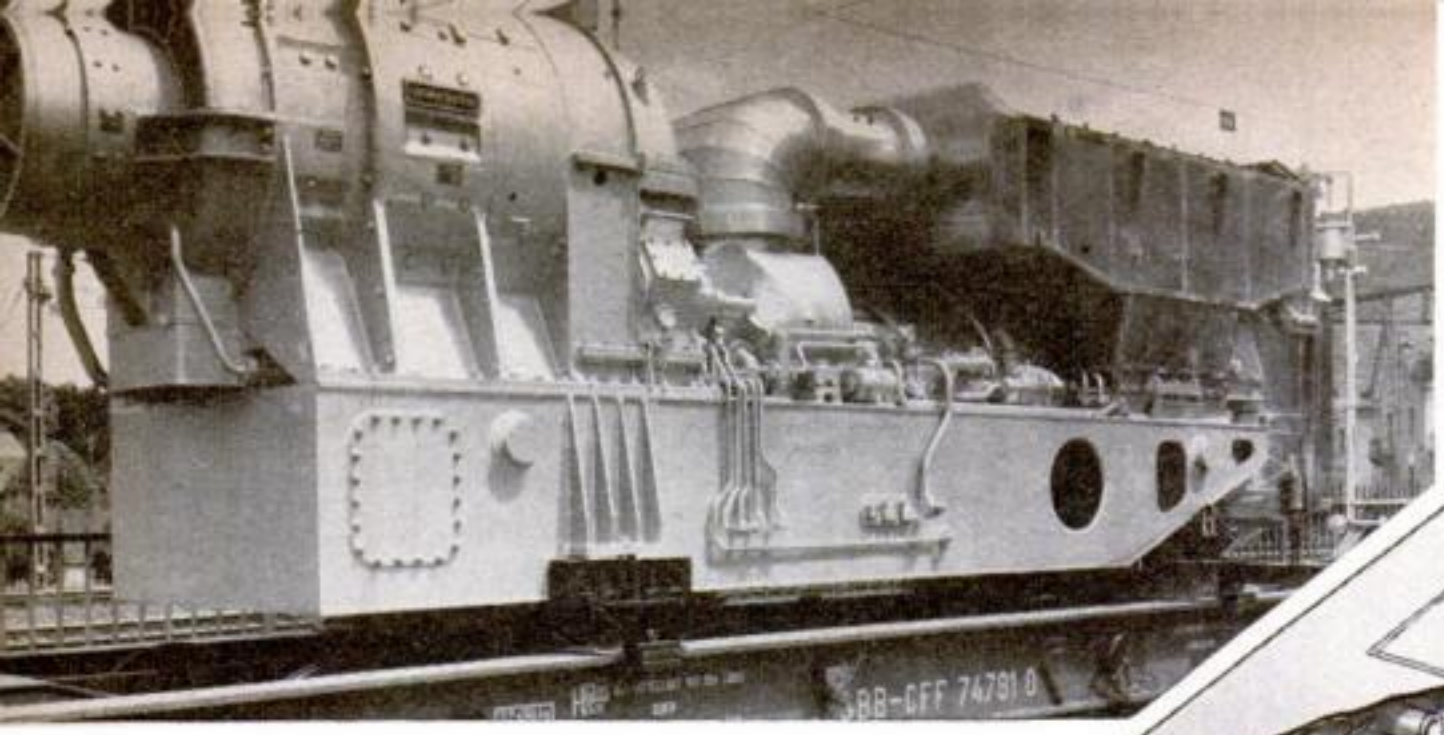
INSULATION TESTING of copper wire used in making electric motors has been made mechanically exact by means of a machine developed by Charles B. Leape (right) of the Westinghouse Research Laboratories. Resembling a lathe, the new tester eliminates the human and mechanical variables that affect the results of hand testing. The wire to be tested is held in a motor-driven chuck that moves back and forth under a scraper at a constant speed of two inches per second. To test the uniformity of insulation on all sides, a spring rotates the wire at intervals. A weak electric current in the wire lights a sensitive neon lamp when the scraper finally makes contact with the copper in the wire.



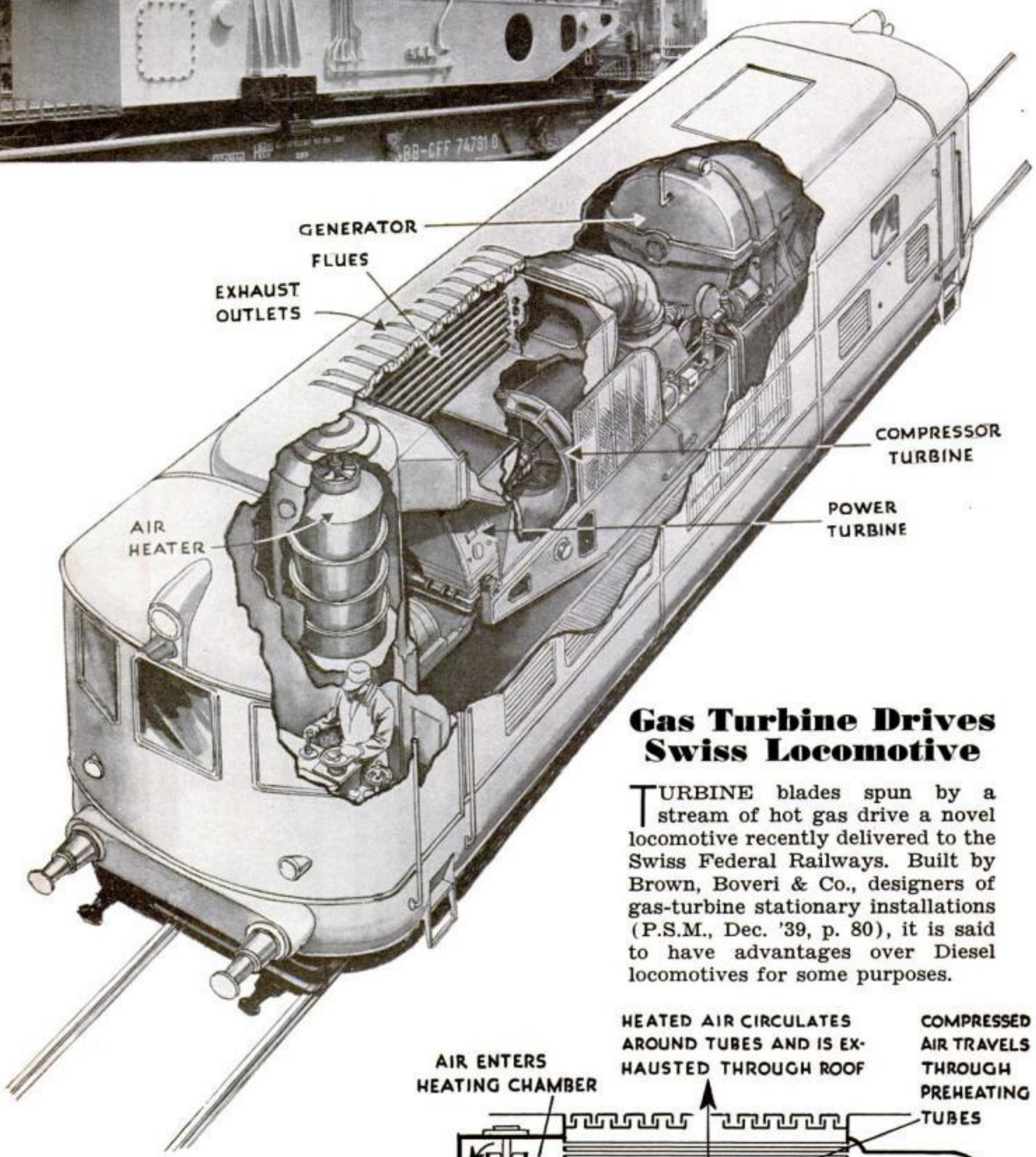


LEATHER FINGER GUARDS introduced by Industrial Gloves Co., of Danville, Ill., give machinists added protection by means of a strip across the back of the finger at the tip. Elastic webbing makes the guards adaptable to any size finger.

A SAND-BLASTING HELMET that looks very much like the type of headgear used by deep-sea divers has now been developed for use by workers at the Boeing Aircraft Company's plant in Wichita, Kan. Weighing but 14 pounds, the helmet is designed to protect workers from the dust particles they encounter in removing dirt from a fuselage with a blasting hose. Continued inhaling of these dust particles may eventually result in pulmonary phthisis. A tube entering the side of the helmet keeps the worker supplied with fresh air. A small glass window at the front enables him to see what he is doing.

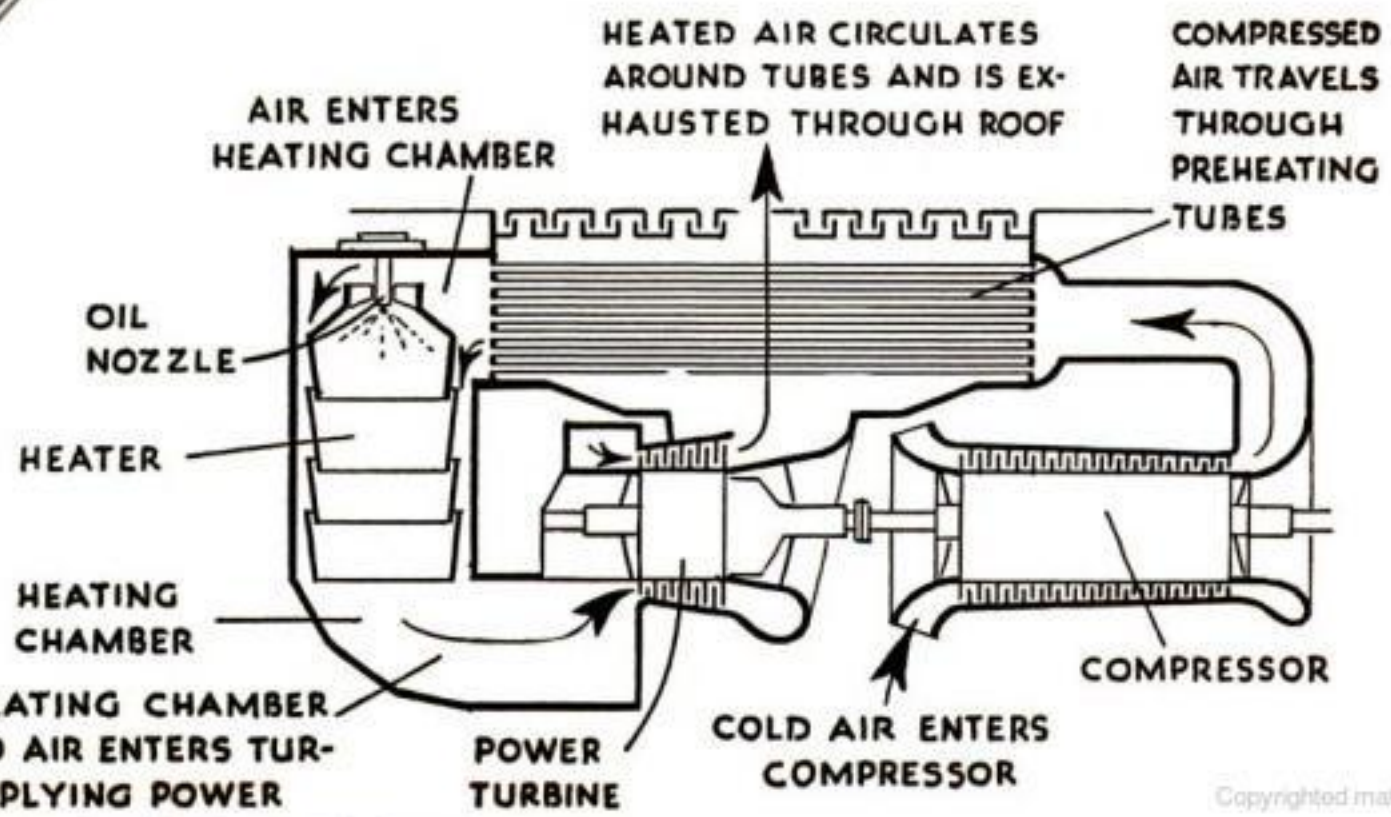


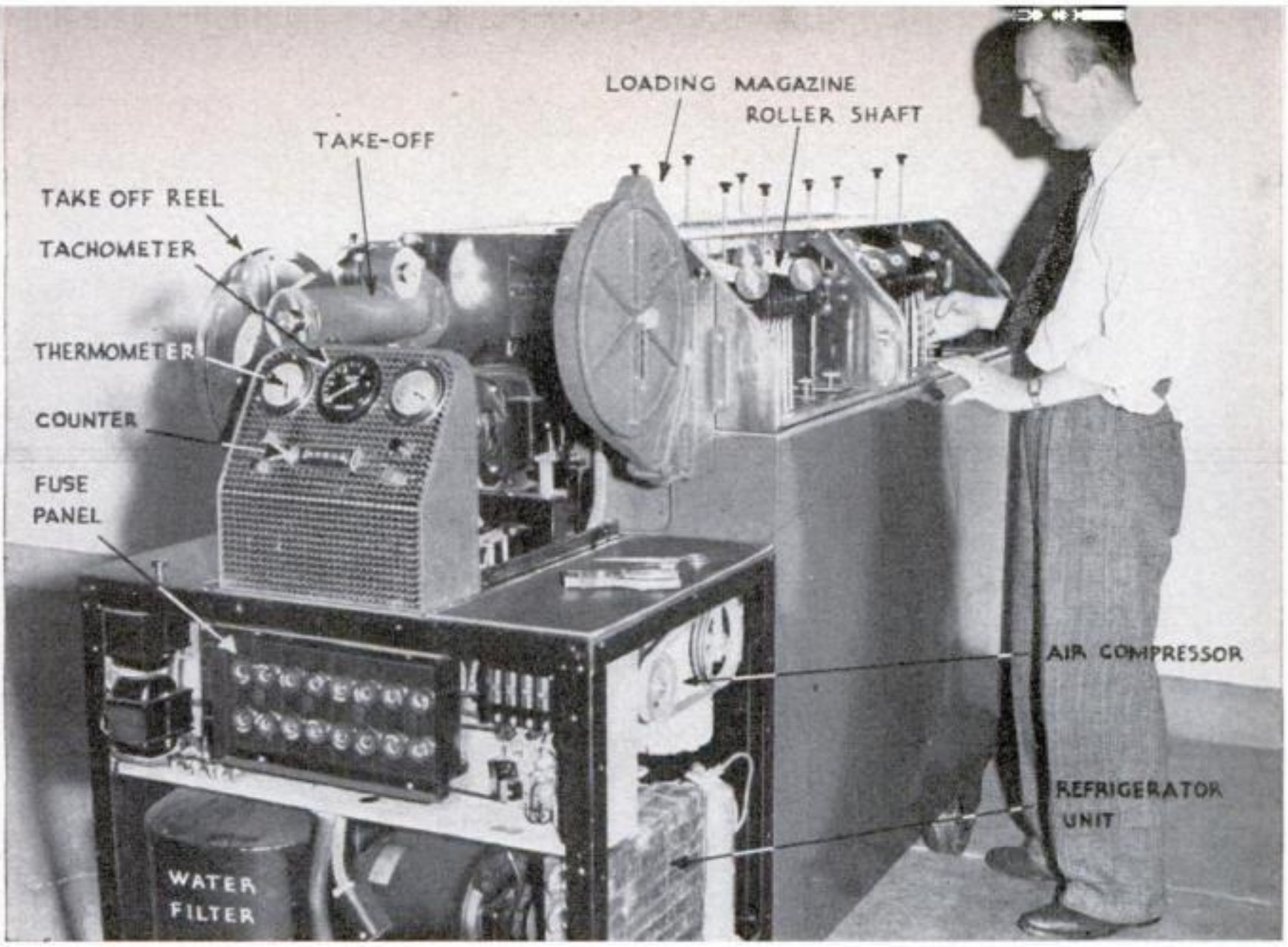
At left is the gas-turbine power plant. The generator appears in the foreground



Gas Turbine Drives Swiss Locomotive

TURBINE blades spun by a stream of hot gas drive a novel locomotive recently delivered to the Swiss Federal Railways. Built by Brown, Boveri & Co., designers of gas-turbine stationary installations (P.S.M., Dec. '39, p. 80), it is said to have advantages over Diesel locomotives for some purposes.

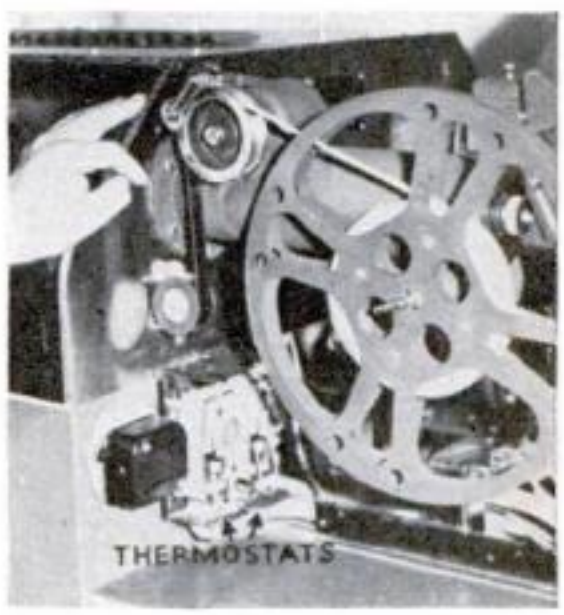




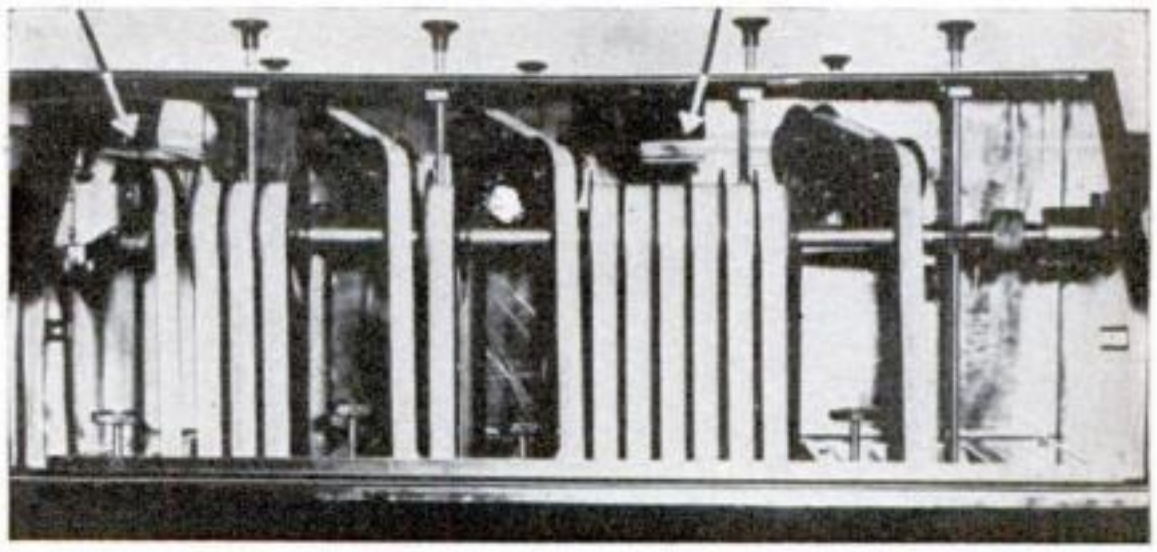
With this portable film processer, Army technicians can develop, print, and dry 16-mm. film, showing enemy installations, at the rate of 900 feet a minute. Our Air Force is now using some of these machines

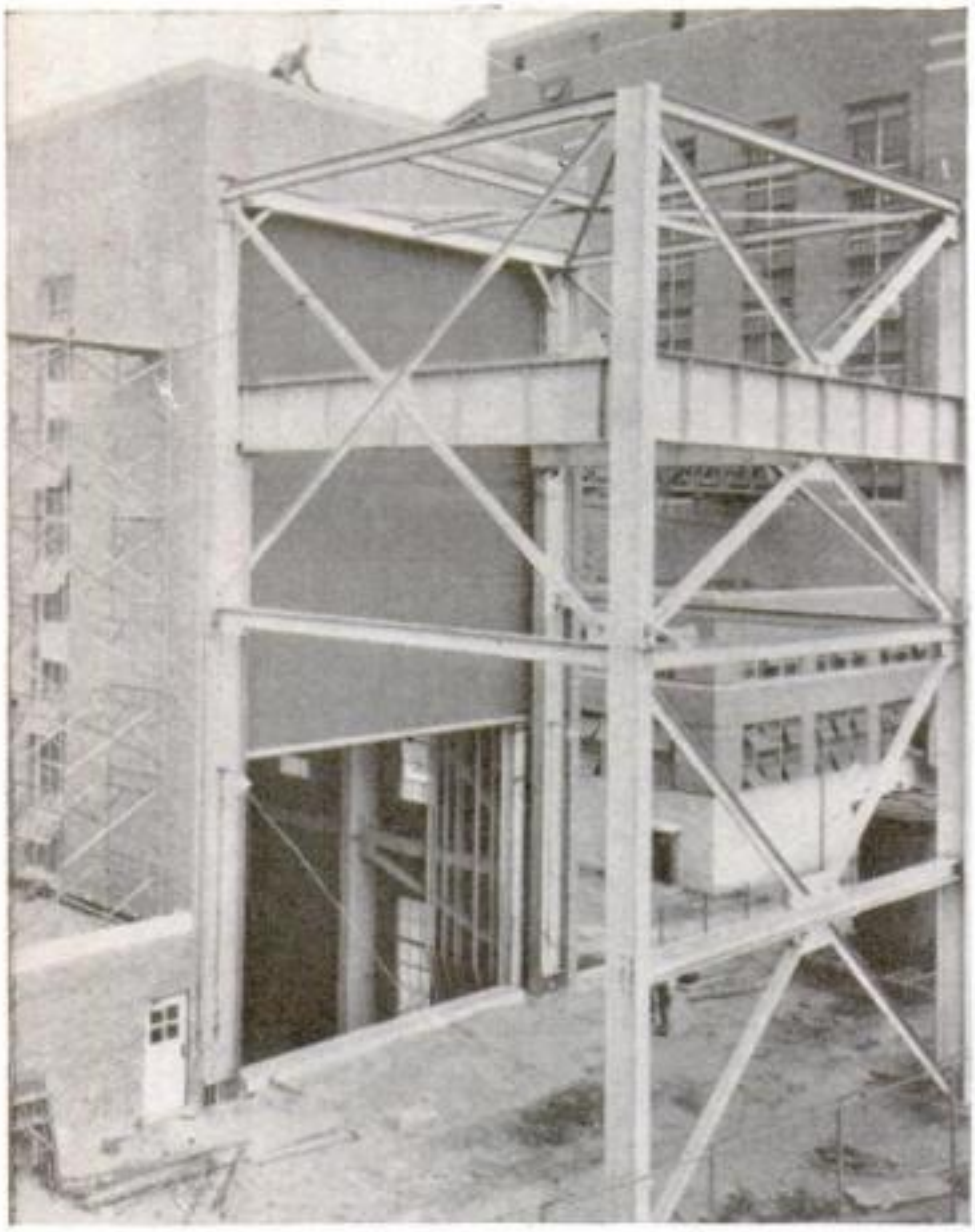
Army Gets High-Speed Film Processer

TO SPEED study of enemy installations by our military commanders, a portable machine produced by H. W. Houston & Co., of Los Angeles, Calif., has been designed to process movie film and have it ready for viewing in 30 minutes. Capable of handling 16-mm. black-and-white film at the rate of 900 feet a minute, the machine can operate in full daylight. After the negative has been loaded into a light-tight magazine in a portable darkroom, the magazine is placed in the machine, and from there the film passes automatically through all the various processing compartments. Refrigerating and heating units keep solutions at proper temperature, and filtered air is used in the drying compartment. Chemicals are supplied to photographic units in measured packages. All the operator needs to do is to attach electric power and water lines, insert the negative, push a button, and wait for the dry positive to wind out on a waiting reel.



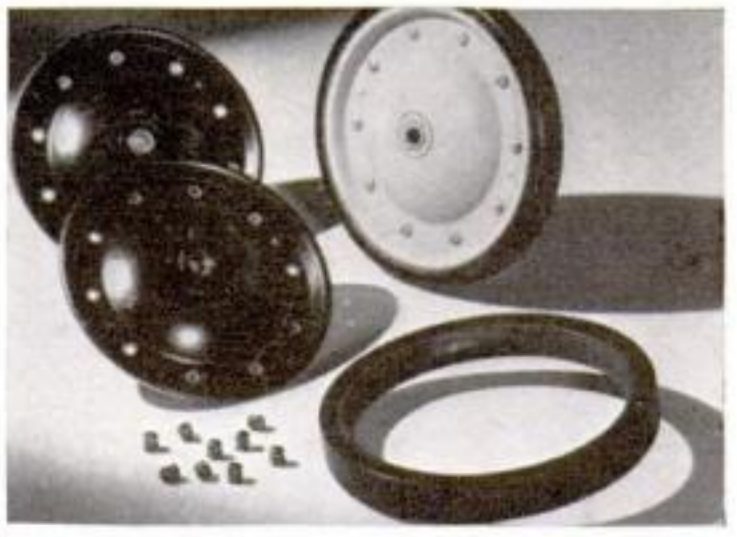
Above left, the negative is attached to the leader previously threaded through the machine (below), and right, the dry positive winds out. Flashing lights control density of the film. In going from first developer to bleaching solution, film passes an exposing light which prints image onto the silver halides of the print. Bleaching removes the silver but does not destroy halides carrying the image. In a third bath, print is developed



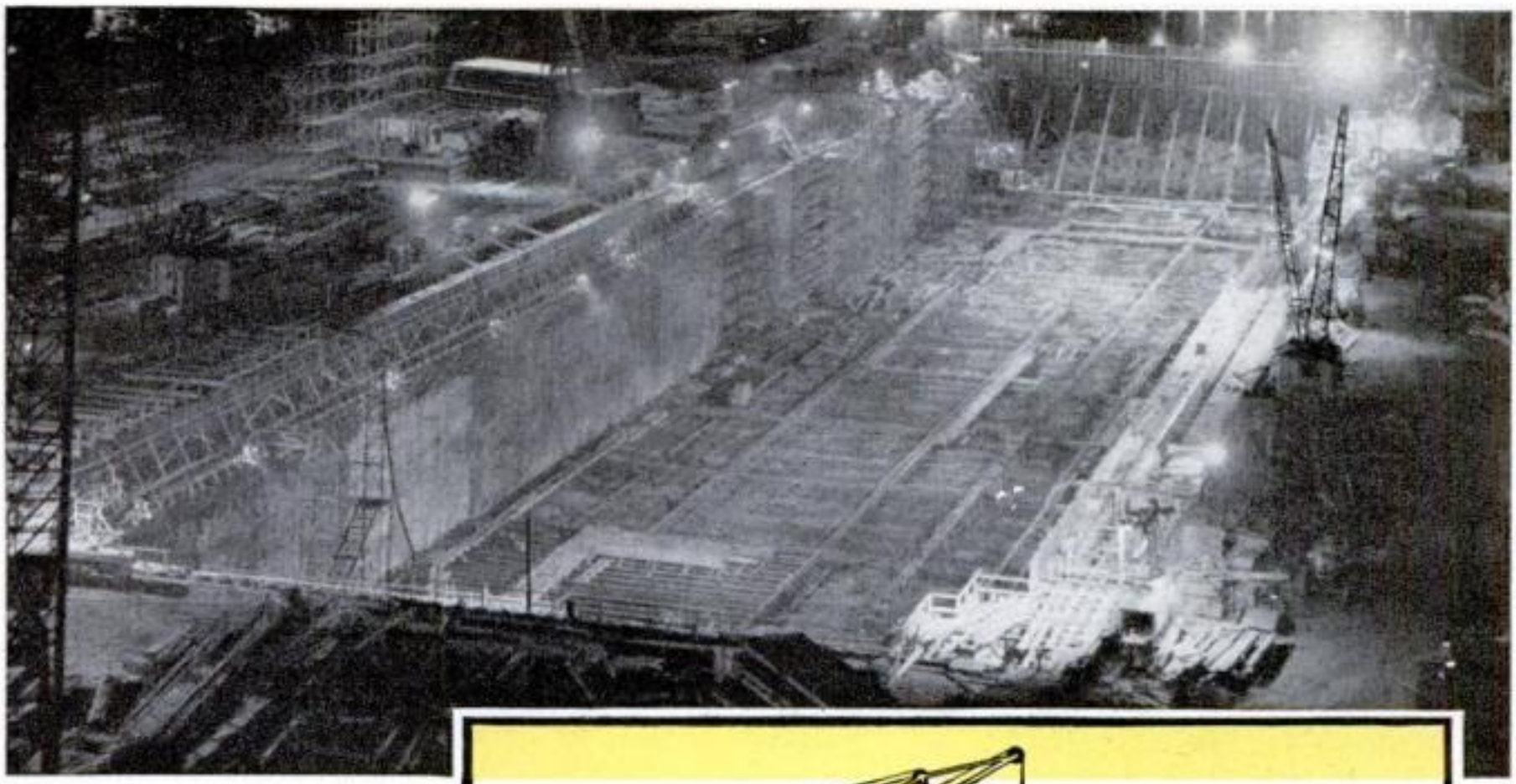


A ROLLING STEEL DOOR, which, when shut, acts as the rear wall of a seven-story building, has recently been completed by the Kinnear Manufacturing Co., of Columbus, Ohio. Construction of the door was occasioned by having to move a 120-ton overhead crane in and out of the building. Made up of interlocking slats, the door opens and shuts by sliding up and down. When drawn up, it coils into a compact cylinder in a small housing on the roof. An unusual safety feature is the air-containing weather strip at the bottom of the door. By means of pneumatic action, this strip automatically halts or reverses the descending door the instant it comes into contact with an object. Actually a curtain of steel, the door is extremely durable, and is constructed so that repairs can be made easily. Smoothness of operation of the gigantic door is attained by means of delicate spring counterbalancing as well as through electric control.

BICYCLE-PEDAL REFLECTORS that throw back the light from the headlamps of approaching vehicles have been invented by Morris Rider, of Detroit, Mich., as a safety device for night-riding cyclists. Mountings easily attached to the pedals contain six reflecting faces apiece, set at various angles to pick up light coming from any direction. Bossings or raised portions of the mountings keep the rider's feet in line on the pedals and prevent interference.

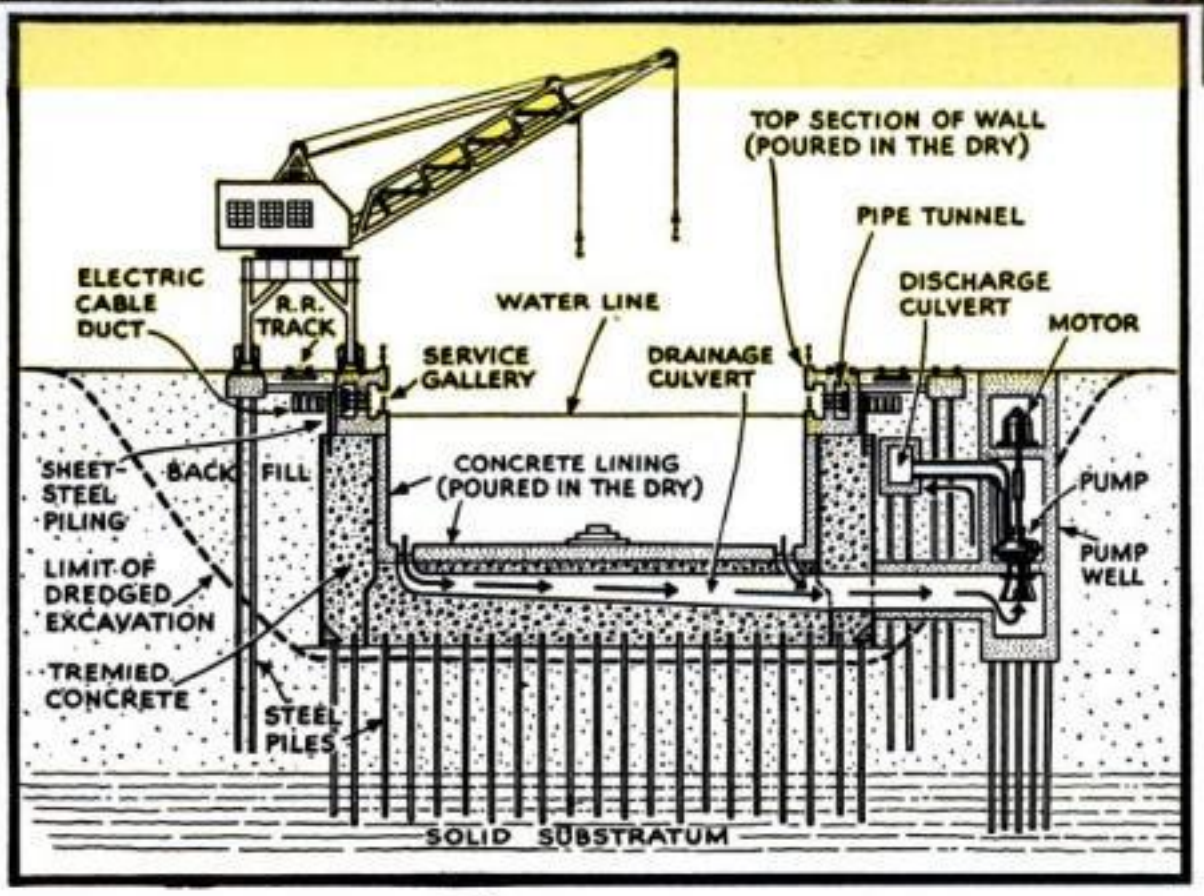


PLASTIC TREADS made by Monsanto Chemical Company from a phenol-formaldehyde compound are replacing rubber tires on small hand-pushed trucks. Although less resilient and a bit noisier than rubber, the plastic treads roll more easily over smooth and rough surfaces, are easier to attach to a wheel, and apparently are resistant to the hardest kind of usage.



Its underwater construction completed, the graving dock above has been pumped dry for the laying of a smooth inner surface of concrete. A gate seat is built in the cofferdam in the background

Tremied concrete encases the main body of the dock, shown in cross section at right. It is poured under water into big steel forms for floor and side walls



Underwater Construction Speeds Naval Dry Docks

MAJOR dry docks are being built for the Navy almost completely under water in strategic areas where the soil is too unstable for big excavations in which the construction can be done "in the dry." This startlingly new type of naval building is known to engineers as the "tremie" method —or pouring large quantities of high-grade concrete under water through pipes called "tremies."

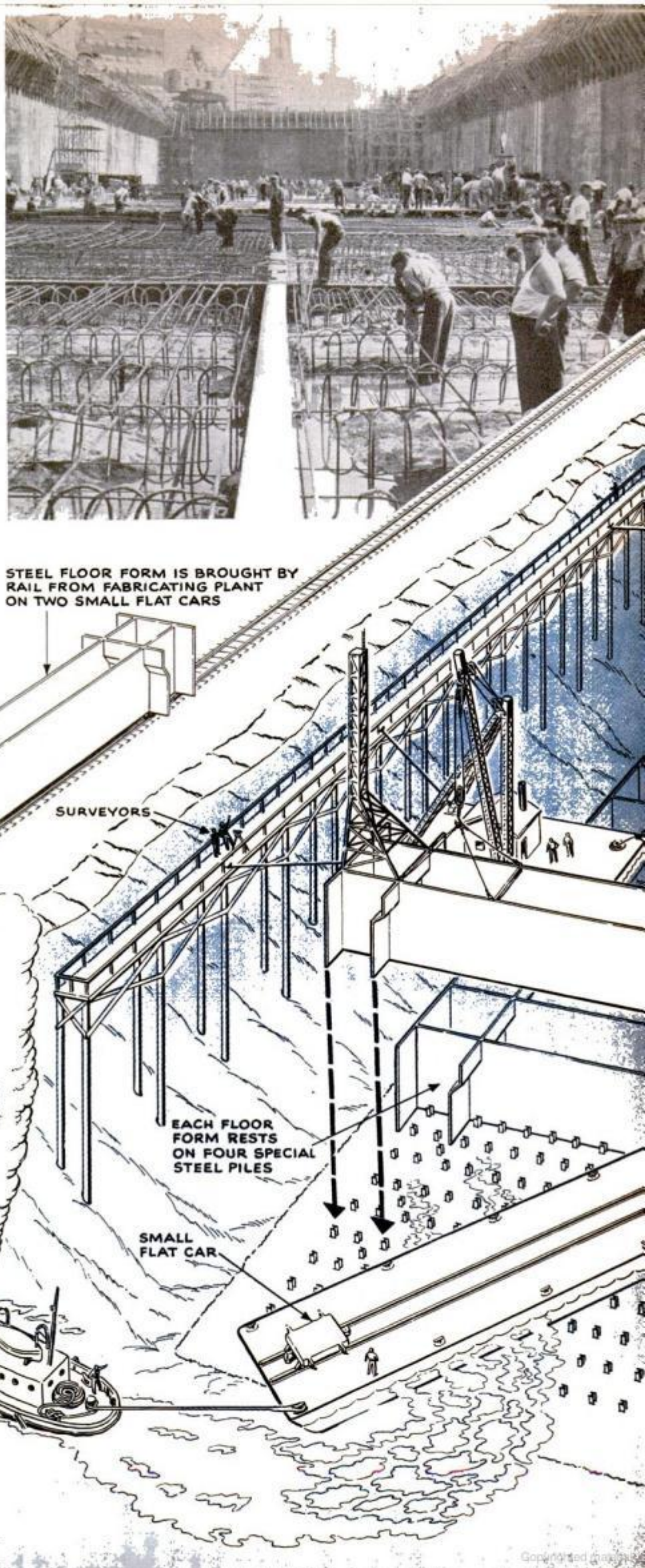
It is providing the Navy with new graving docks for repair and overhaul of fighting ships that must be sent with dispatch to rejoin the fleet. And it gives the Navy these bases where they are most needed—no matter how difficult the site—without the long delay required for erecting big cofferdams that would otherwise be needed to keep water out of the excavations in which the docks are built.

Now a site is simply dredged to the desired depth, then leveled by barge-controlled drags, and construction begins. First come the steel foundation piles, driven down to a firm substratum by a floating pile driver equipped with extension leads and a steam or compressed-air hammer capable of working under water. They must fit a pattern in both line and grade, and those that cannot be driven down far enough are cut off by

Bent steel rods that look like huge hairpins protrude from the tremied concrete to provide a bond for a smooth finishing slab poured on the floor "in the dry"

divers using underwater torches.

On certain of these piles are laid huge floor forms having neither top nor bottom, each watched carefully by two teams of surveyors to be sure it goes down accurately. Meanwhile, the tremie scow sets to work, filling the forms with concrete. Side walls are next laid and filled. A steel cofferdam, sealing the opening, is then put up to provide a dry space for building the gate seat, and the dock is pumped dry. After this, installations are completed.—*Contributed by Capt. W. Mack Angas, Civil Engineer Corps, U.S.N.*



EXCAVATION AROUND DOCK IS FILLED WITH EARTH WHEN CONCRETE POURING IS FINISHED

7 WALL OF STEEL PILING REACHING ABOVE WATER LINE IS INSTALLED BEFORE SIDE-WALL FORMS ARE FILLED

6 DERRICK PLACES SIDE-WALL FORMS WHICH ARE THEN FILLED WITH CONCRETE BY TREMIE SCOW

5 TREMIE SCOW SUPPORTS CONCRETE PIPES AND DIRECTS CONCRETE TO FILL FLOOR FORMS

GRAVEL CARS

CONCRETE PLANT MIXES SEMI-FLUID CONCRETE AND PUMPS IT TO TREMIE SCOW

TREMIE PIPES

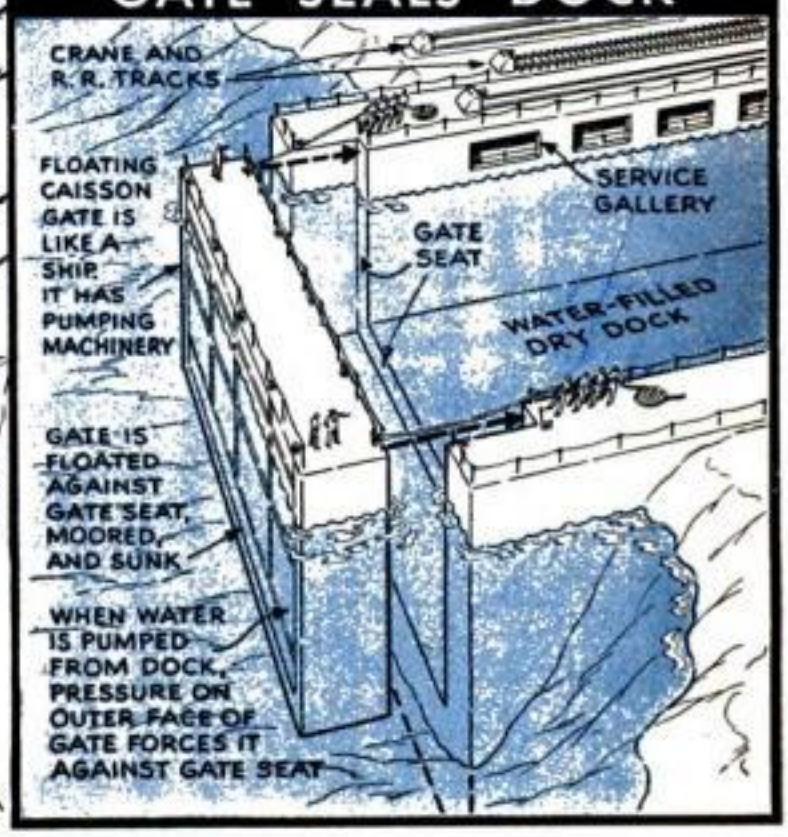
TEMPORARY TOWER USED AS GUIDE BY SURVEYORS WHILE PLACING FORM

4 FLOOR FORMS ARE LIFTED FROM RAILROAD CAR BARGE BY FLOATING DERRICKS AND LOWERED TO CORRECT POSITIONS ON BOTTOM

SURVEYING CREW

END SPACES ARE FILLED WITH CONCRETE WHEN SIDE-WALL FORMS ARE FILLED

GATE SEALS DOCK



3 TEMPORARY TIMBER PIER IS BUILT FOR USE BY SURVEYORS AND FOR MOORING TREMIE AND DERRICK SCOWS

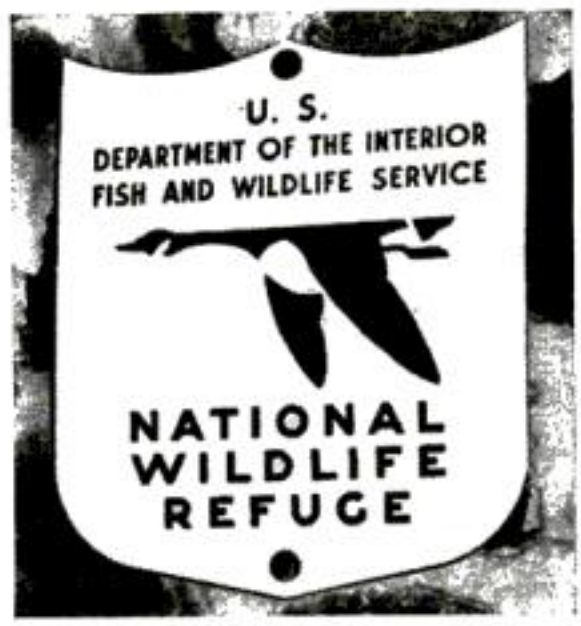
2 STEEL PILES, REACHING DOWN TO A FIRM SUBSTRATUM, ARE DRIVEN IN PLANNED PATTERN BY FLOATING EXTENSION PILE DRIVERS

1 2' LAYER OF CRUSHED ROCK IS APPLIED TO BOTTOM OF ENTIRE DRY-DOCK SITE

Food from the Wild

SCIENCE RANSACKS NATURE TO MEET WARTIME DEMANDS

Photographs by William W. Morris



This sign marks the Patuxent Refuge in eastern Maryland, where research seeks new wartime uses for nature's riches

MEET a new kind of fishermen. Using neither hooks, seines, oilskins, nor rubber boots, they've caught a whopper which promises to change our diet. President Roosevelt, himself no mean wielder of rod and reel, arranged their fishing party. It was with test tube and microscope—and out of all the fish in the ocean they found just the right one to meet a war shortage. Their catch is the menhaden. If you've never heard of it, you soon will. For this prolific fish is the choice to pinch-hit on the home front for the salmon going to our overseas troops and our allies. It's known off Jersey shores as the mossbunker, heretofore regarded as a scrap fish.

That curious fishing expedition is but one of the wartime activities of scientists of the United States Fish and Wildlife Service at the 3,000-acre Patuxent Wildlife Refuge in eastern Maryland. You find them carrying on, for the first time anywhere, successful experiments in polygamist quail breeding to speed propagation; they are giving the red fox and other prized fur-bearing animals a new lease on life by their work in disease prevention; they have figuratively counted the noses of this nation's big and small game animals to the benefit of hunters and depleted beef stocks; they have kept a constant check on the flyways to protect ducks, geese, and upland birds; they have found new food for these birds and animals; and, by a queer turn, they have brewed poisons to take the place of poisons cut off by the war that were our only means of controlling the propagation of harmful and destructive birds and animals.

Poison brewing became urgent soon after the first torpedo of World War II exploded. Red squill, one of the most effective anti-rodent poisons, came from the Mediterranean area. Nux vomica, another death dealer, came from territory now overrun by the Japanese. Thallium, perhaps the most deadly of all, came from Germany. Even before the war, when these poisons were easily obtained, the annual damage in this country from rats alone amounted to $189,000,000. So the need for substitutes was great.

The Patuxent chemists tackled the job with a pharmacological and chemical approach that revealed the poison principle of the imported drugs. Then they attempted to match it. Into their laboratory came hundreds of native plants to be tested for poison content. Into their test tubes went scores of chemical combinations to create synthetic poisons. It wasn't long before they had prepared 150 specimens. These were rushed to the Fish and Wildlife Service laboratories at Denver for actual tests in killing. Findings showed the Patuxent chemists had uncovered 10 American plants with poisoning potentialities equaling those of red squill and nux vomica. These plants, existing in great abundance, are Indian hemp, calfkill, stagger grass, larkspur, American hellebore, death camass, monkshood, Jimson weed, water hemlock, and poison hemlock. Poisons from these plants are obtained by a simple process of distillation and concentration.

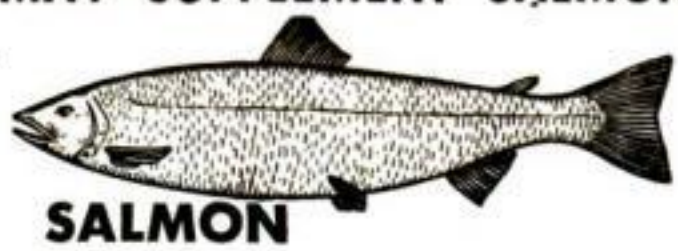
When the war began making heavy inroads into our beef supply, the Government again turned to Patuxent. Experts there got together data from all parts of the country, announced there were 6,000,000 big-game animals of which 600,000 could be taken annually without endangering any of the species. This represents 60,000,000 pounds of meat a year for our dinner tables. Added to this, the service estimated a possible yearly kill of 10,000,000 ducks and geese, 20,000,000 rabbits, 15,000,000 upland birds, and 4,000,000 other small game.

Maintenance of this great potential food supply was the tough problem. Present was the danger of disease, shortages in wildlife foods, and the elimination of certain species by hunters. Research in disease prevention and nutrition had been carried on by the service for years, but under peacetime conditions. New ways and means had to be

THE RED FOX is one of the few non-paying guests of the Patuxent Refuge. Because the demands of war have now made him difficult to obtain, his place as an experimental animal has been taken by much commoner ones—rats, white mice, and ferrets. Findings by the Patuxent experts in methods of preventing disease among fur-bearing animals are passed on to breeders

found. War made it virtually impossible to obtain expensive test animals such as red fox and mink. So the scientists turned to other sources, and began breeding more ferrets, white mice, and guinea pigs. They put hen eggs to an amazing use. Eggs were placed in an incubator until the embryo was well formed. Inoculated with a virus or disease-producing bacteria, the embryo served as a living culture

MENHADEN MAY SUPPLEMENT SALMON AS WARTIME FOOD FISH



	SALMON	MENHADEN
WEIGHT (Av.)	15 pounds.	1 pound.
LENGTH (Av.)	3 feet.	1 foot.
COLOR	Steel-blue or gray, black spots.	Iridescent, greenish-brown.
HABITAT	Near coast, North Temperate Zone. Enter rivers, September to February, to spawn. Pacific varieties more numerous, supply most food.	Near coast, Atlantic seaboard of the Americas, from Nova Scotia to Brazil. Belongs to same family as herring, sardine.
AVAILABILITY	Ample supply for normal needs. Choke rivers in spawning time.	Most plentiful fish on eastern coast. Travel in large schools.
NORMAL USE	Food. Greatest commercial value of any food fish. Small amounts used for salmon oil (medicinal, paints, soap). About 25% (heads, tails, fins, viscera) used for fertilizer.	Fish bait, oil, fertilizer. Body pressed for oil for paints, varnishes, tanning leather. Dry waste makes valuable fertilizer with high nitrogen content.

medium within its own sterile package. It took the place of living test animals in finding protective and curative agents for diseases of wildlife. Results of experiments were passed on quickly to wildlife refuges, naturalists, zoologists, and the nation's fur farmers.

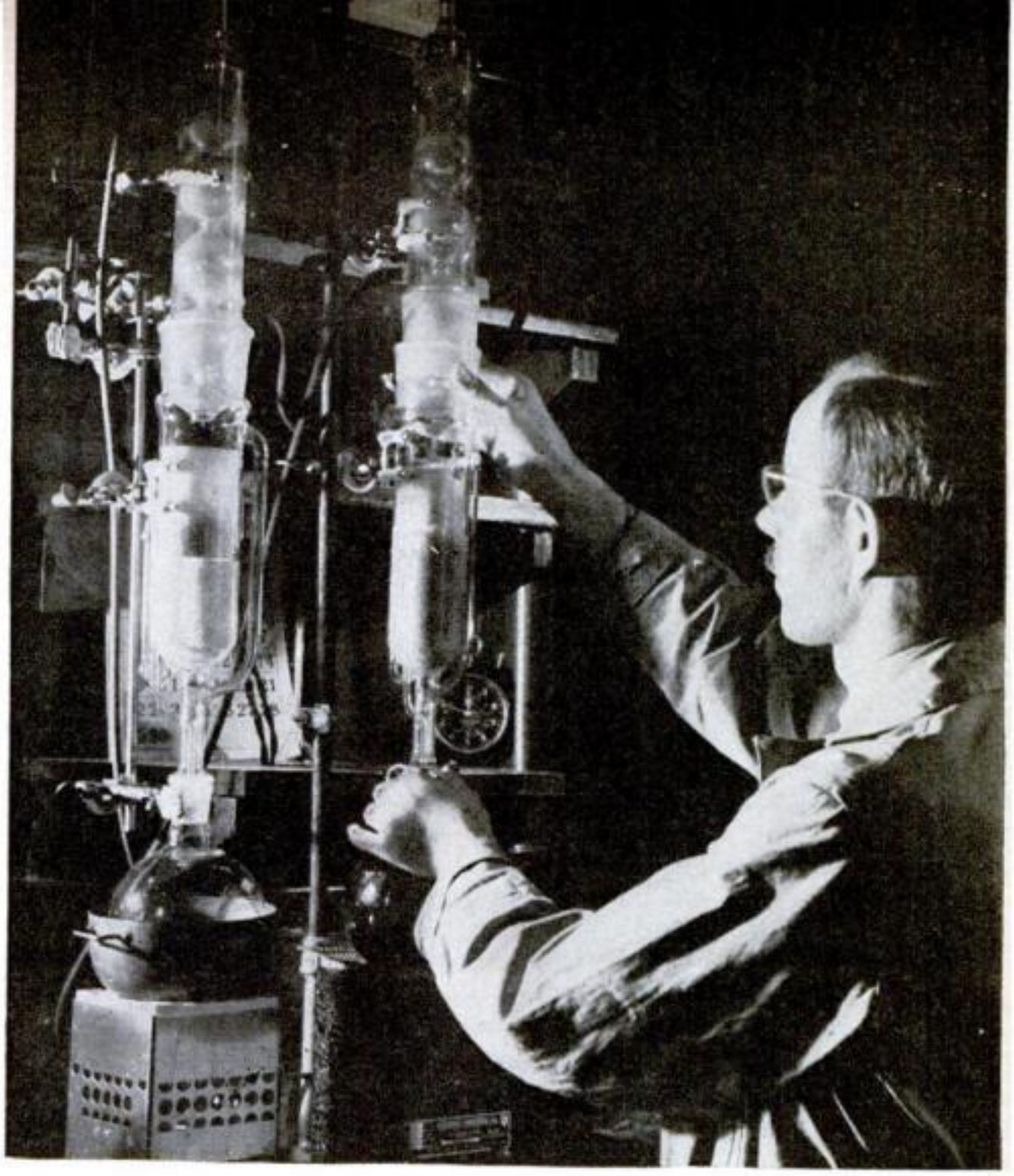
Three thousand bobwhite quail were raised at Patuxent last season. The main objectives were to increase propagation and to develop new quail foods that could be supplied under war conditions. Both were achieved. Quail are inveterate monogamists. They were introduced to polygamist breeding. Male birds were placed in pens with three, six, and 12 females. The fertility of the eggs fell off as much as 50 percent as compared with normal mating, but the increase in egg production spelled success. The radical change in the quail's home life caused some disturbing incidents at first, with an occasional death from fights caused by jealousy. As the season wore on, however, most of the breeders accepted the new setup.

The Patuxent scientists meticulously charted a complete cycle in quail life—from egg to chick to breeder to egg—keeping individual records of all birds raised. This was important in developing the new diet in which soybean meal, corn meal, and other nourishing foods were used in place of riboflavin concentrate, sardine fish meal, and other things needed for the war.

Another task was the development of natural foods for migratory fowl. About half a mile from the main Patuxent laboratory is a series of 24 ponds, each 50 by 30 feet. There experts studied and experimented with aquatic and marsh plants. Their findings may prevent the starvation of great numbers of ducks and geese in crowded breeding grounds.

With a million duck hunters in this country, it is imperative to have regulations that will maintain the supply in sufficient quantity to permit the annual forays to marsh, lake shore, and river bank—in war as well as in peace. These regulations are not the vagrant thoughts of some official. They are devised each year after long and careful study by the Fish and Wildlife experts. The Patuxent Refuge is the clearing house for all information used to establish hunting and fishing laws. During migrating, breeding, and wintering seasons, a constant flow of reports comes from field personnel and co-operating outdoorsmen.

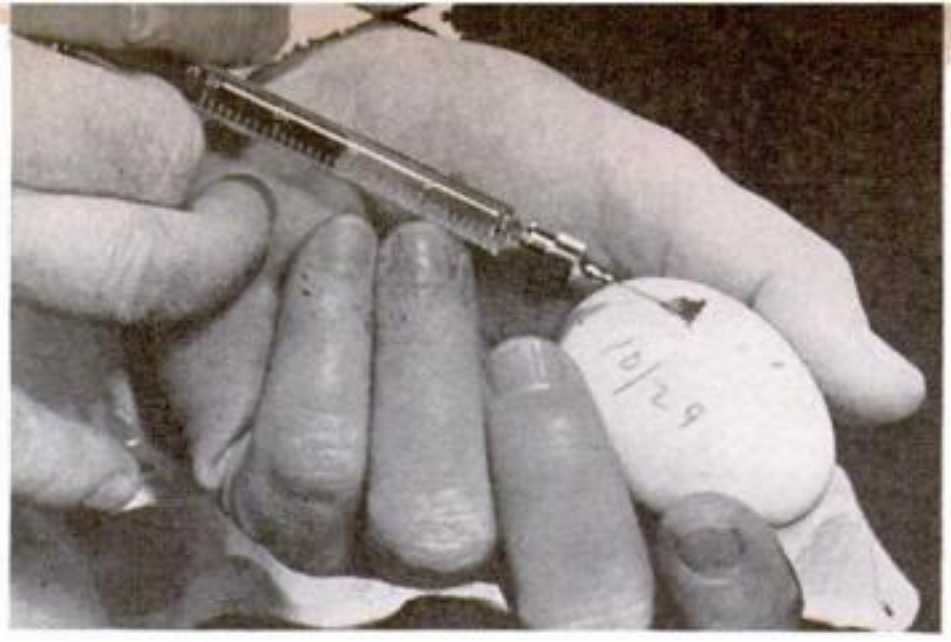
The service's bird-banding system is a source of information of the highest accuracy. Of nearly 4,000,000 birds marked with the numbered aluminum bands, 250,000 have been subsequently reported. This has supplied a file of precise details on sex, age, and migrating habits. Some ducks have carried bands for 15 years, though the average bird is reported within two or three years of banding. From the moment of banding all information on the bird is tabulated. Cards at the Patuxent refuge are kept with the same care and, indeed, by the same method as the Federal Bureau of Investigation's fingerprint system. The cards are passed through a perforating machine which notes number and other data. Later it takes only a few seconds to locate the cards by passing the file through a shuffling machine. Wartime shortage of aluminum



Brewing poisons to supplant those formerly imported for the purpose of controlling the propagation of destructive birds and animals is one of the Refuge's most important war jobs. Here a chemist is operating two Soxhlet extractors used to derive toxic elements from native plants. From hundreds of these plants technicians prepared 150 specimens which were delivered to the Fish and Wildlife Service laboratories in Denver for actual tests in killing. Results show that Patuxent chemists had found at least 10 American plants capable of producing poisons every bit as effective as those formerly employed

Studies of migratory birds are made by means of marking them with numbered leg bands before they are released. On a similarly numbered file card, a record is made of the bird's health, age, and sex, to which is added information which may be received from a hunter. Banding is now curtailed because of the lack of aluminum. Left, a duck watches with interest as a sample of its blood is taken

A dated egg carrying a live chick is drilled preparatory to its being inoculated with a virus



The virus is injected into the embryo, which will act as a culture within its own sterile package

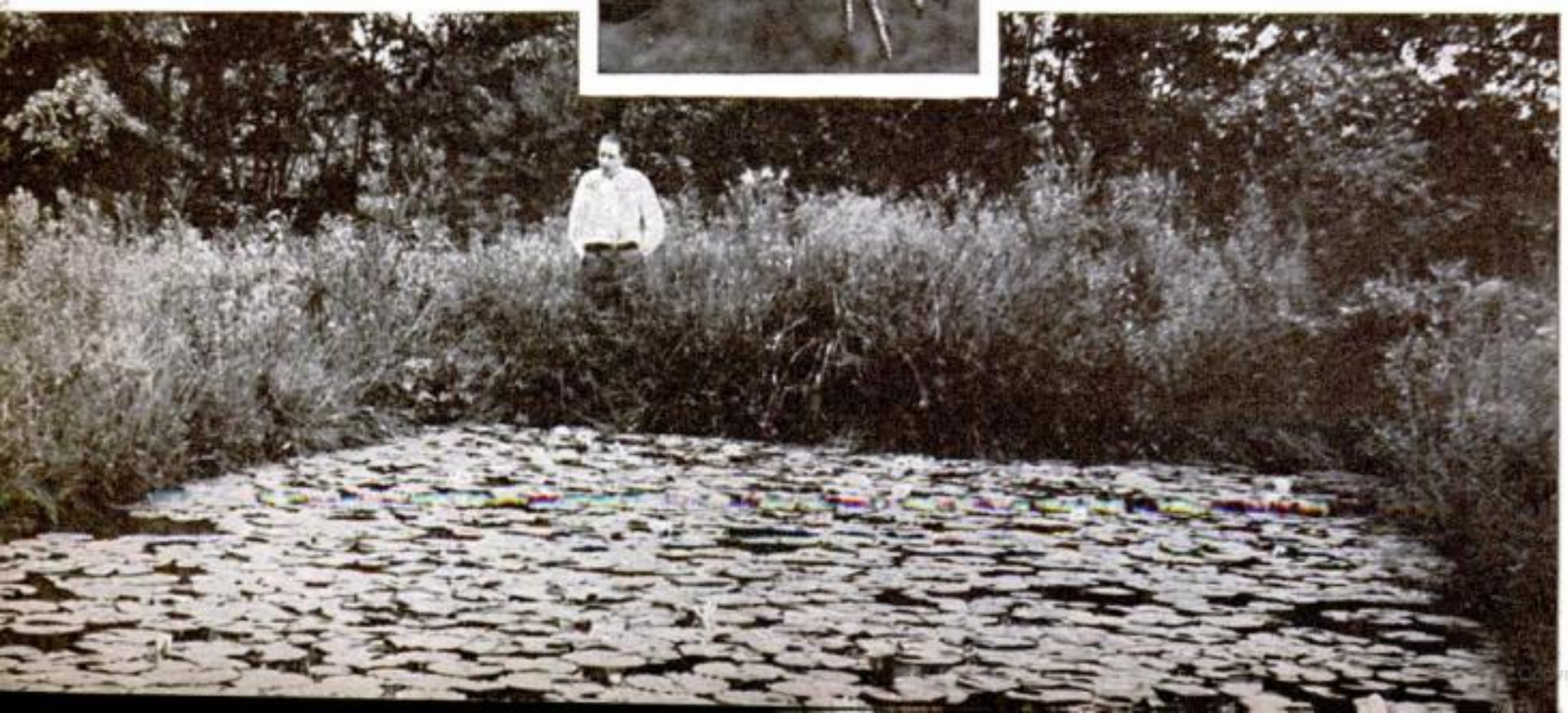
has caused officials to cut down on banding, but they are maintaining the *status quo* of the system as far as possible.

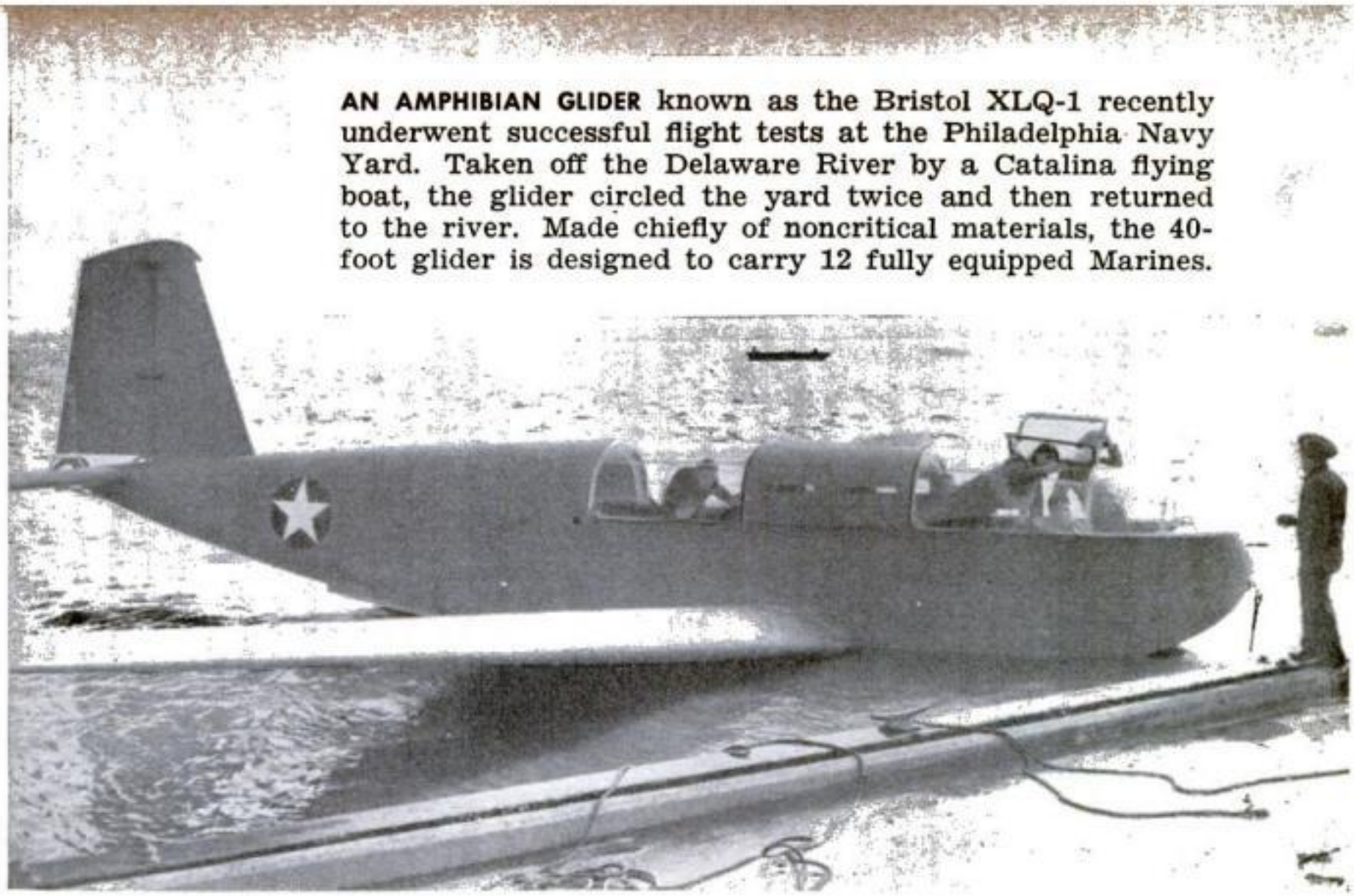
It was on July 21, 1942, that President Roosevelt called on scientists of the Fish and Wildlife Service to find a substitute for salmon. What he hoped for was a fishing expedition as successful as the one that brought tuna—then unknown as a food fish—to our dinner tables in the last war. What he got was the menhaden, which not only may surpass tuna as a tasty dish but vies with salmon in food value and abundance. Though its name is of American Indian origin and its abundance has been known for years, the menhaden has never been sought for as food. The millions of pounds taken each year along the Atlantic seaboard have been pressed for oil and used to enrich the soil. Much smaller than either tuna or salmon — it ranges from 12 to 16 inches in length when mature—the menhaden travels in great silvery schools and is easily captured with large nets.

In their survey, the Patuxent scientists tested hundreds of American fish for edibility and food value. For their purpose, fish were hauled in off the rock-bound coasts of Maine, the shores of Jersey, and the palm-fringed Florida keys. Big fish and little fish, deep-sea fish and estuary fish—all were studied. Fish to be tested were first canned at the Federal Fisheries Laboratories at College Park, Md. At Patuxent, the scientists removed the fish from the cans and placed them in digestive racks—simply glass retorts—which released the nitrogen content as ammonium sulphate. The ammonium sulphate was then placed in a Kjeldahl distilling rack where the ammonium was passed off as a nitrate. By neutralizing and measuring this nitrate, the chemists were able to calculate the amount of protein in each type of fish. They also found that alewives, hake, and sea herring have a high food value and make very tasty dishes. So these, too, may soon find their way into our kitchens.—JACK O'BRINE.

Right, a 17-week-old quail, whose excellent health is a tribute to Patuxent experiments in breeding

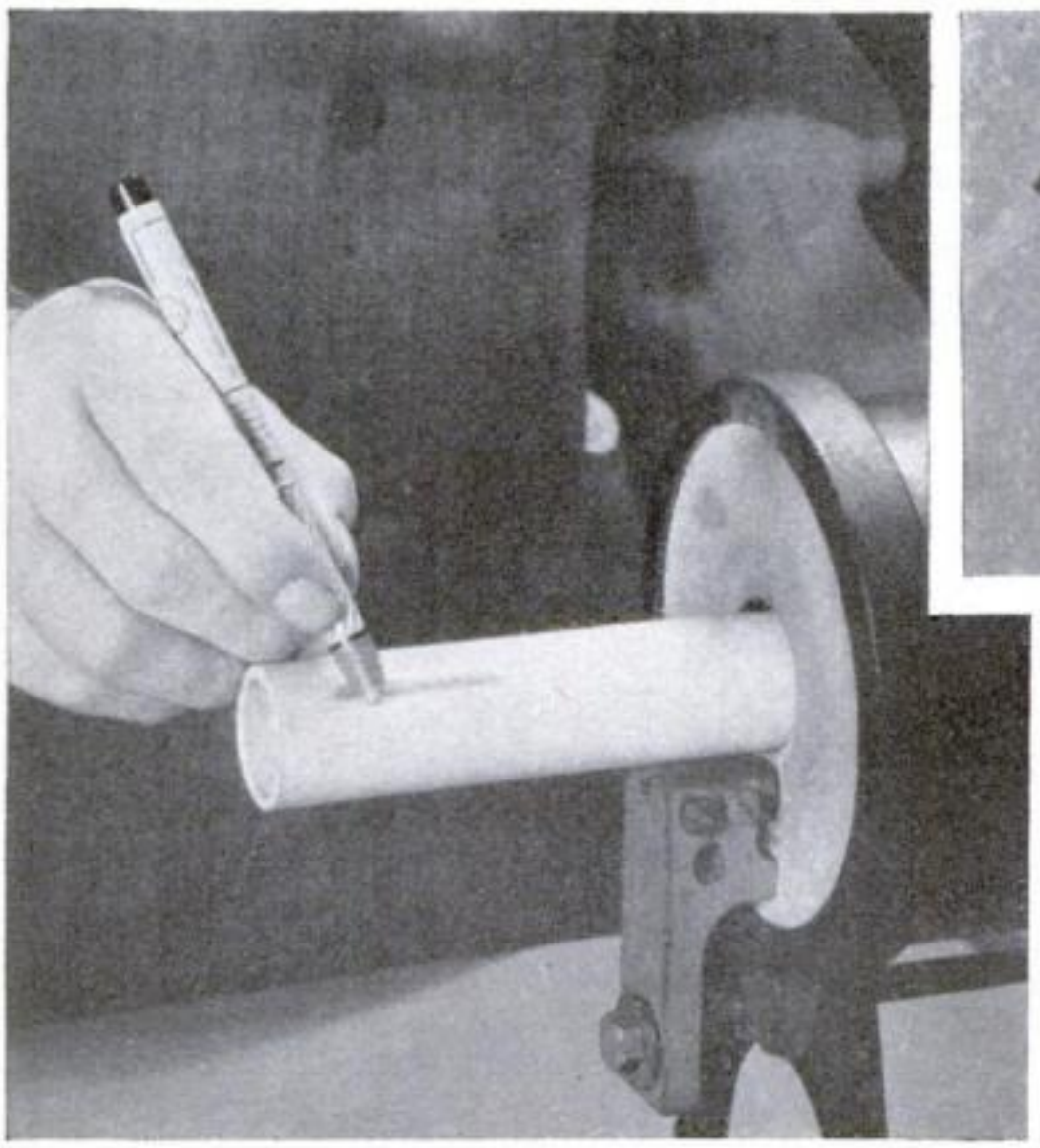
One of the 24 ponds used to test aquatic plants that might be used in the feeding of migratory birds

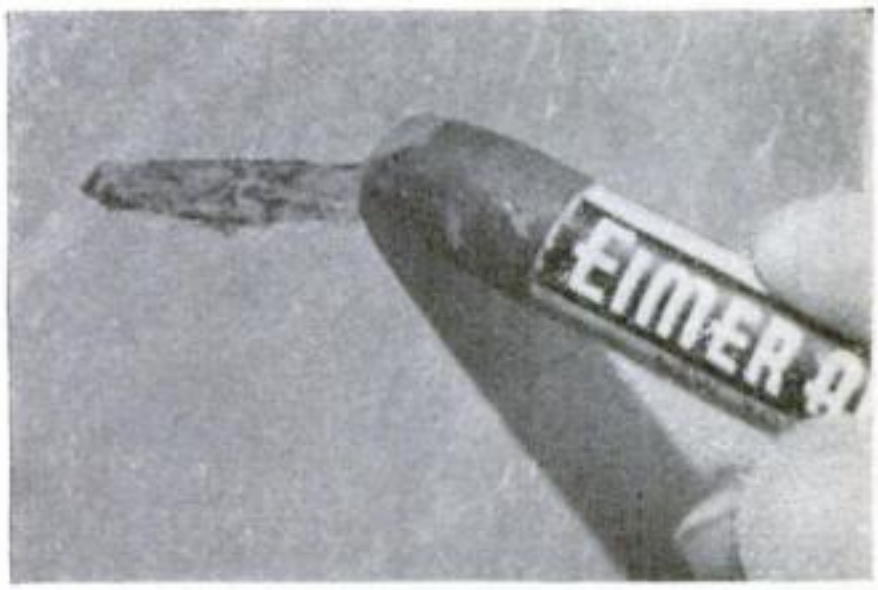


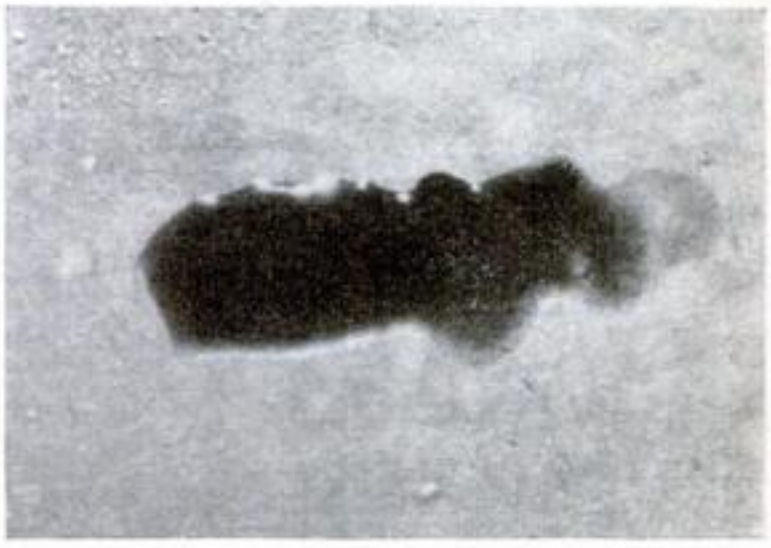


AN AMPHIBIAN GLIDER known as the Bristol XLQ-1 recently underwent successful flight tests at the Philadelphia Navy Yard. Taken off the Delaware River by a Catalina flying boat, the glider circled the yard twice and then returned to the river. Made chiefly of noncritical materials, the 40-foot glider is designed to carry 12 fully equipped Marines.

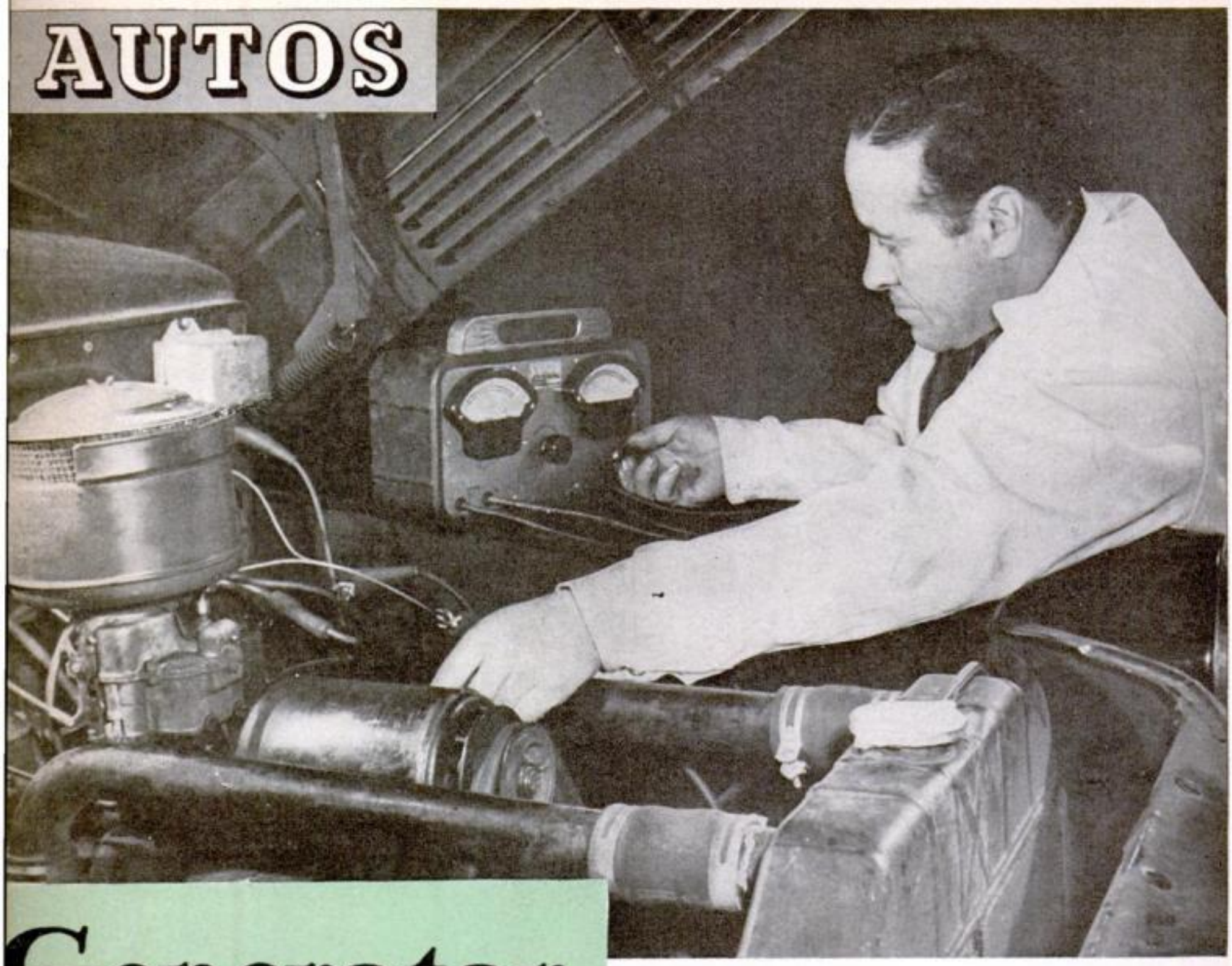
Melting Pencil Mark Warns of Overheating







PENCILS whose marks will melt within one percent of a predetermined temperature are providing industrial and laboratory workers with an easy and inexpensive means of checking various surface heats. A mark is made on the surface to be tested with a pencil of a known temperature rating. When the mark melts, the operator knows that the surface has reached that temperature. The crayonlike pencils come in 15 different ratings, each of which is identified by a distinct color, and cover a range of from 125 degrees F. to 700 degrees F. Known as Tempilstiks, these pencils have proved highly successful in heat-treating operations and in checking the surface temperatures of machinery, motors, and insulation. At above left, a Tempilstik is used on a combustion tube. At right, a pencil mark begins to melt (below) when heat nears pencil's rating.



Generator Care

Your Car's Powerhouse Must Serve for the Duration . . . Don't Neglect to Check It

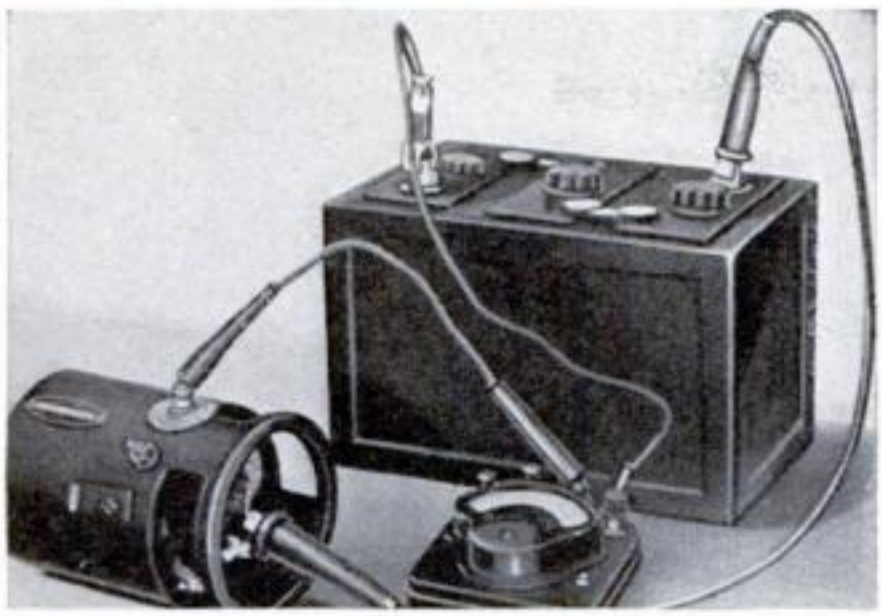
By Ralph Rogers

PERIODIC inspections of the generator on your car are important not only because it is the vitalizing center of the entire electrical system, but also because its innards are chock-full of materials now difficult to replace. The generator is probably one of the most neglected units in the average car, yet it alone produces the current that charges the battery and energizes all the various parts which depend upon electricity for their operation. If the generator fails, your car must eventually go dead. This can best be prevented by the simple expedient of locking the door *before* the horse is stolen. An inspection of the generator should be made every 5,000 miles, or at least once a year regardless of mileage.

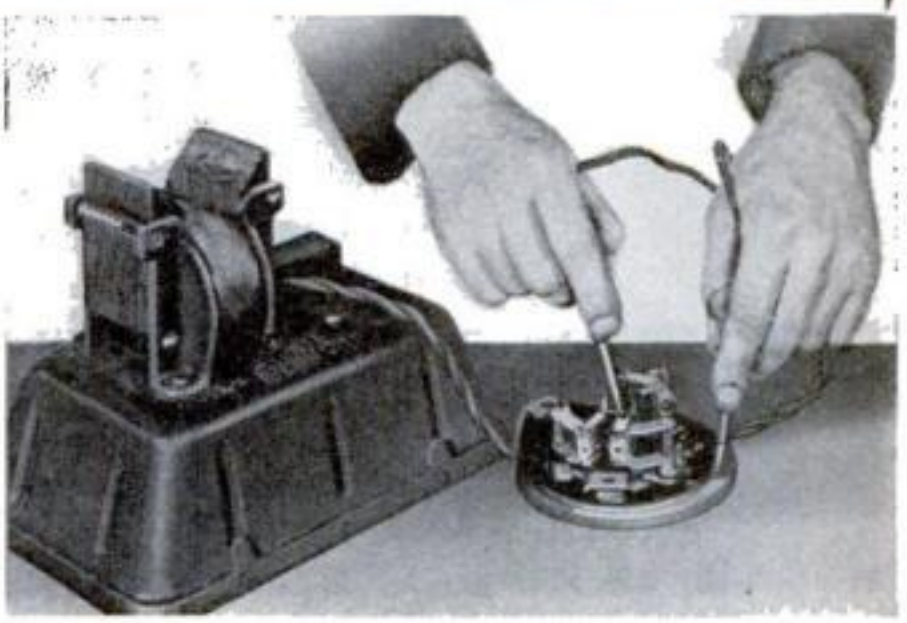
To insure satisfactory operation and to prolong the life of parts, the generator should be disassembled, thoroughly overhauled, and cleaned as a safeguard against the accumulation of dust and grease. At the same time, check the external circuit on your car for defective wiring and loose or corroded connections at the battery, starting motor, ammeter, and similar places Loose or corroded connections in the charging circuit will cause high voltage, resulting in damage to the generator and its regulating device, and will greatly shorten the life of the ignition points, light bulbs, and battery.

While the various gears in your car may revolve as fast as the armature of the generator, the gears are protected by a film of oil. In the generator, on the other hand,

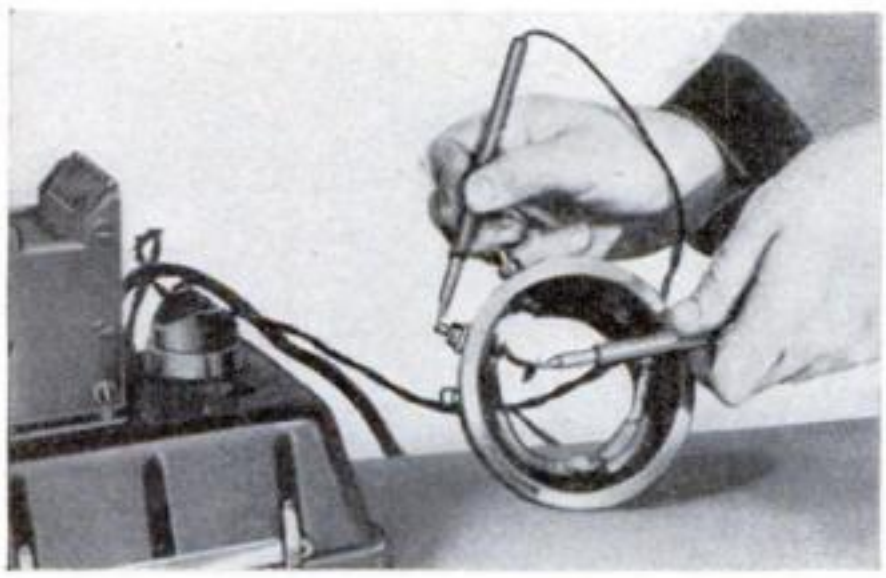
STEP-BY-STEP DETAILS OF A GENERATOR MAINTENANCE JOB



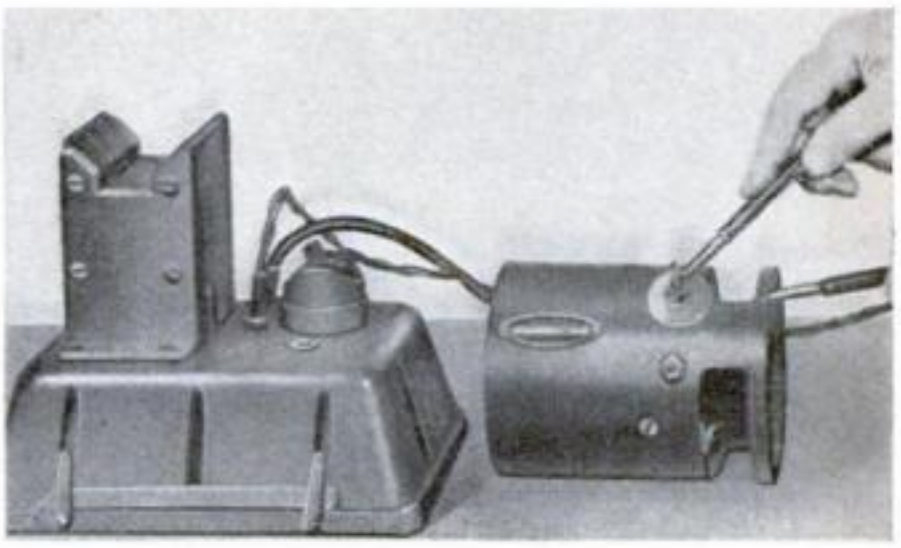
INTERNAL-FIELD SHORTS are checked with one prod between coils with insulation removed and the other on end of each coil in turn. Replace any coil drawing more current than specifications allow



IF TEST LAMP LIGHTS with one point touching the negative brush holder and other prod placed on the end frame of generator, the negative brush holder is grounded and will have to be replaced



CONTINUOUS-CIRCUIT TEST is made with one test point contacting the negative terminal and the other on the end of the brush lead. If the test lamp does not light, there is an open circuit



REPLACE FIELD COILS if test lamp lights when one testing prod is on the generator frame and the other on the field terminal. Disconnect grounded end of field winding from the frame for this test

are parts bearing on each other at high speed without benefit of a protective film of oil—the commutator and brushes. These are subject to heat and friction, and servicing the generator is largely a matter of checking up on these important but vulnerable parts.

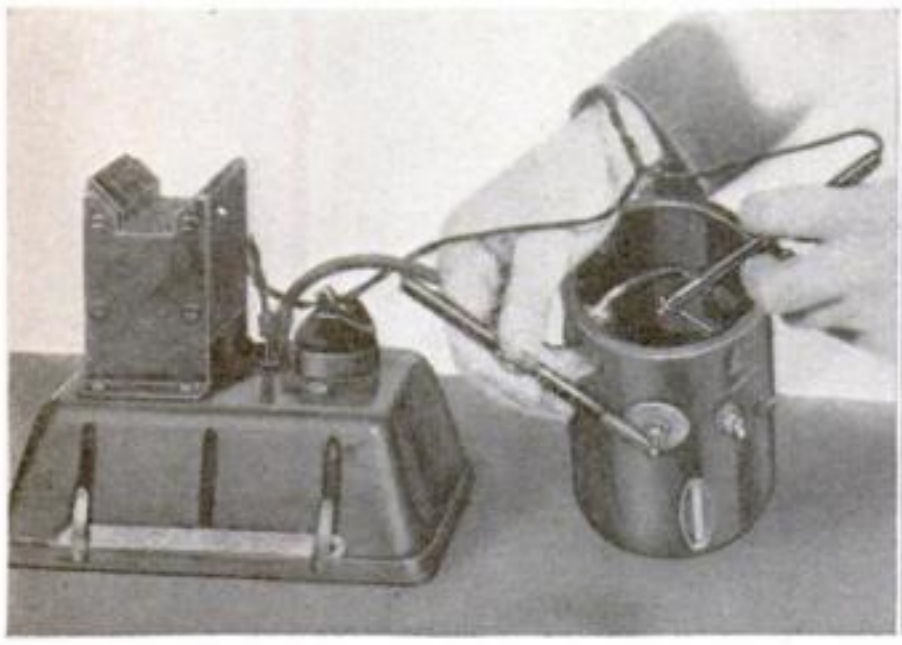
Examine the commutator and, if it is dirty, clean it with a strip of fine sandpaper, No. 00 preferred. Do not use emery cloth, as emery dust may become embedded in the commutator and brushes, causing rapid wear of these parts. After the commutator has been cleaned, the dust must be blown out. If the commutator is rough, out of round, or has high mica, it must be turned down on a lathe, but only enough material should be removed to true it up and to eliminate any roughness or high mica. After the lathe operation, the mica should be undercut, as shown in the illustration on page 129.

Armatures must never be cleaned by any degreasing method, as a grounded or shorted condition will very likely be the consequence.

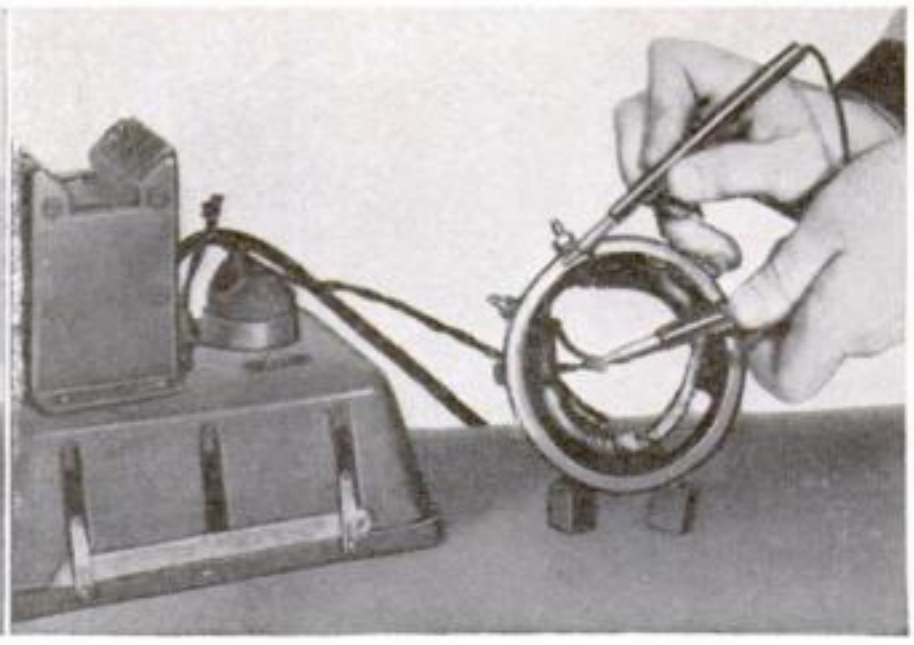
It is important that brush springs have the correct tension. If the tension is excessive, rapid commutator and brush wear will result. On the other hand, if the spring tension is weak, it will cause decreased generator output as well as arcing and burning of brushes and commutator. If either of these conditions is evident, install new brush springs.

When it becomes necessary to install new brushes, they should be seated by using either a brush-seating stone or No. 00 sandpaper. If sandpaper is used, wrap a strip of it around the commutator with the sanded side out. Then place the brushes down on the sandpaper, pulling the sandpaper under the brushes in the direction of normal

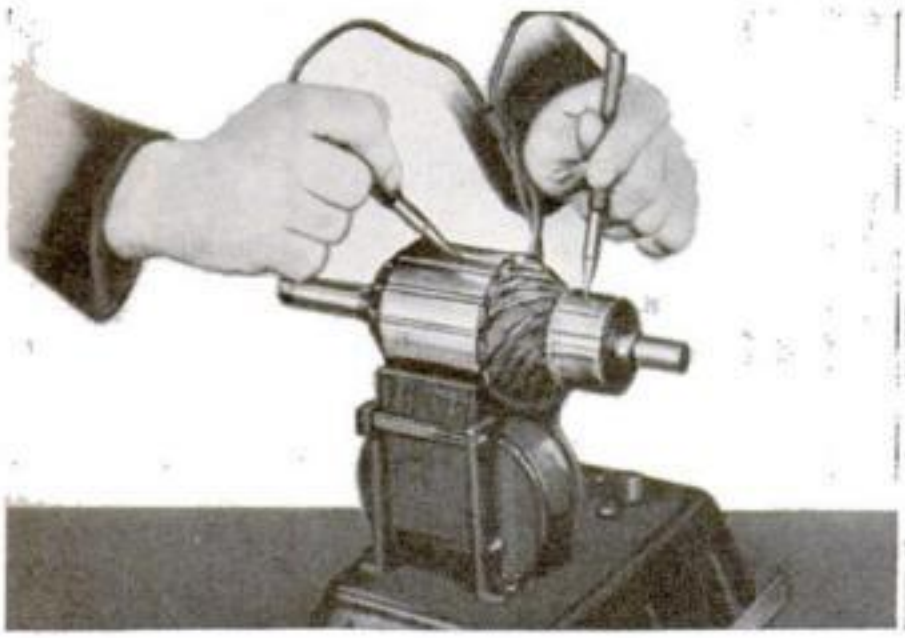
FIND OPEN CIRCUITS, GROUNDS, AND SHORTS IN THIS WAY



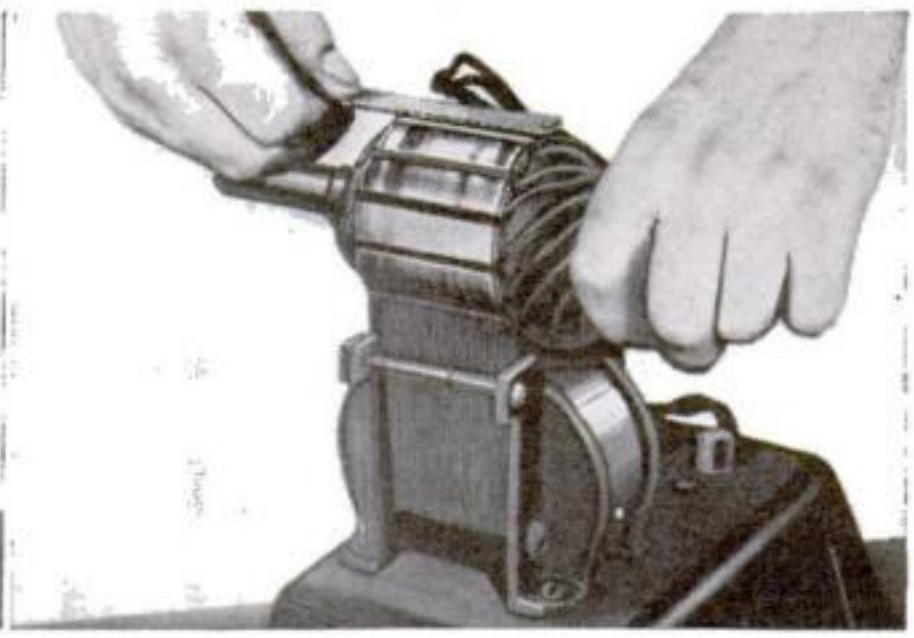
THE TEST LAMP LIGHTS with the points held as shown if the field coils have a continuous circuit. If the test lamp does not light up, the field coils have an open circuit and will have to be replaced



WHEN TESTING TERMINAL for ground, place one testing prod on the terminal and the other prod on the generator frame. If the lamp doesn't light, the terminal is O.K.; otherwise the insulation is poor



A GROUNDED ARMATURE can be detected by the placing of one test point on the armature core and the other on the commutator bars. If the test lamp does not light, there is no ground in the armature



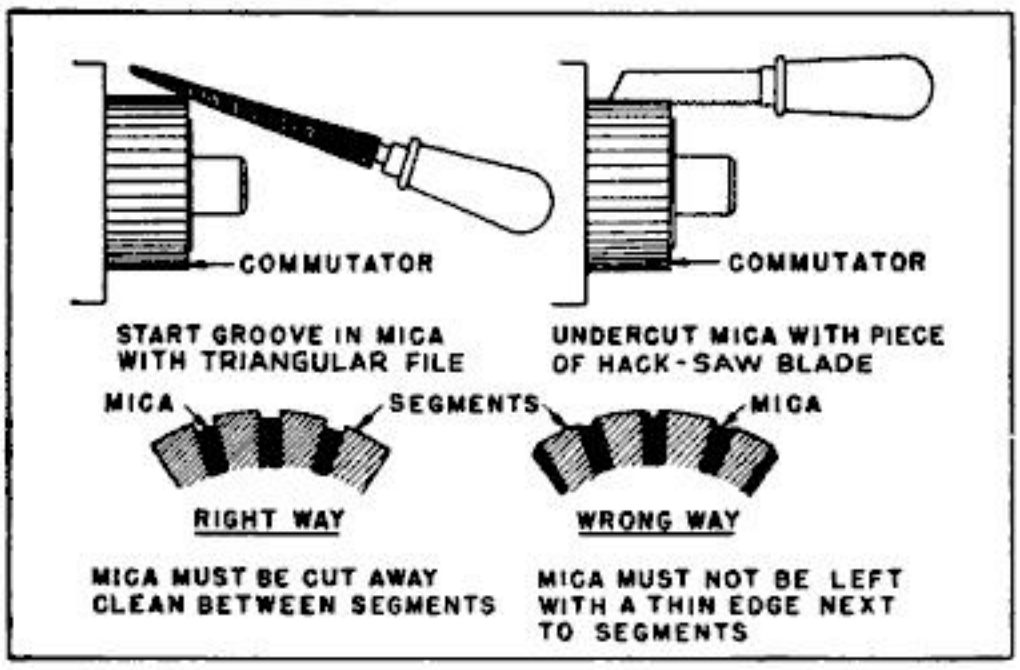
COMMUTATOR AND ARMATURE shorts are detected with the armature on a growler. First clean between commutator bars; then rotate armature. If hack-saw blade vibrates on it, armature is shorted

armature rotation until a good brush seat is obtained. If a brush-seating stone is used, the generator may be driven on a test stand, or it may be connected to a battery and "motored." With the generator operating at medium speed, press the stone firmly against the commutator, moving it back and forth to cover the entire commutator area contacted by the brushes. Do not use the stone any longer than a few seconds, as unnecessary wear of brushes and commutator will result. After the brushes are seated, blow out the generator to remove all dust and abrasive particles.

In removing brushes from their holders, pull back the spring or arm; then lift out the brush. Never remove a brush by pulling on its pigtail lead against the spring tension, for you may loosen the connection in the brush and cause a high resistance to develop. Such resistance might produce an overheated condition resulting in damage to the generator. Nor should a brush spring or arm be snapped down on the brush, as this may crack or break the brush.

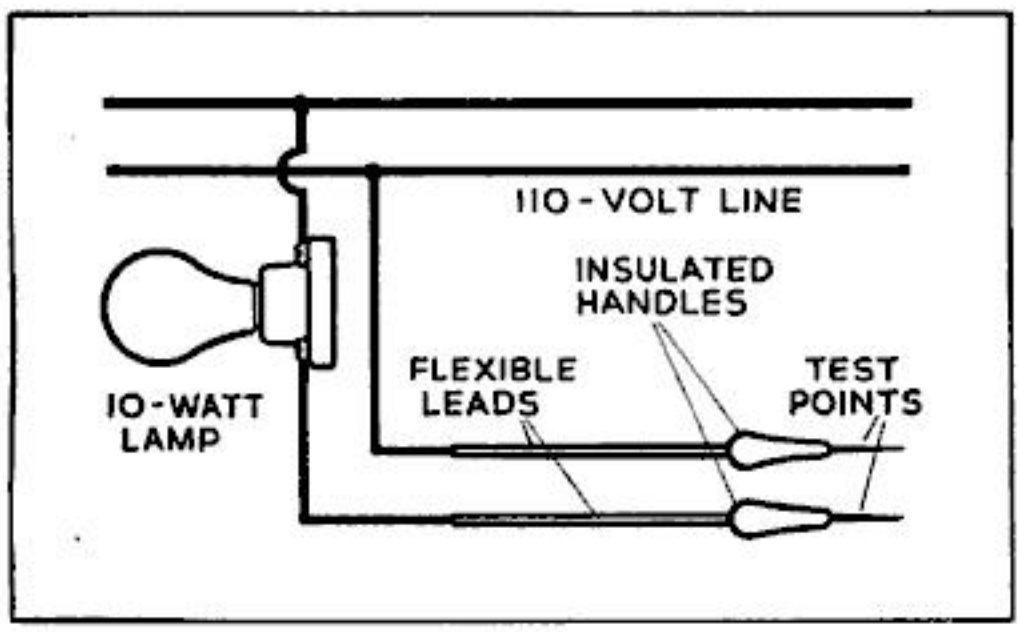
If for any reason the field coils are removed, do not attempt to clean them by any degreasing method, as this might damage the insulation and cause a ground or short when the coils are put back in the field frame. If the insulation is worn, burned, or chafed, it is sometimes possible to rewrap the field coils with insulating tape and paint them with shellac or insulating compound. This operation should be performed by a competent automotive electrician so that the coils will fit under the pole shoes properly when replaced. All soldered connections should be made with rosin flux, for using acid flux sooner or later will

Commutator Care Is Important



THE COMMUTATOR is a particularly sensitive part of the electrical equipment of your car. Its segments, from which the brushes pick up current, must have sharp, clean edges with no rough spots. Mica between must be undercut

A CONVENTIONAL TEST LAMP used for locating open circuits and grounds in a generator can be readily made by wiring a socket and two prods having insulated handles as below. An ordinary 10-watt lamp serves the purpose



cause corrosion of those parts it touches.

Generator ball or roller bearings should be washed in clean gasoline, kerosene, or carbon tetrachloride. The bearing should be swished thoroughly in the cleaner until all dirt and grease are removed. Immediately after cleaning, spin the bearing in light engine oil until all cleaning solvent is removed; then pack with bearing lubricant, Whenever a bearing is to be pressed off or on a shaft, or out of or into an end frame, damage will be avoided if the pressure is applied only to the inner bearing race.

Assuming that a generator-regulating device is functioning properly, yet the generator is not performing according to specifications, its trouble may be localized by proceeding as in the following tests. These are applicable to units on recent models, and can be made without removing the generator from the vehicle in most cases.

If there is no current output, and if the ammeter is known to be in good condition and shows the generator not charging, the first thing to do is to remove the generator cover band and check for sticking brushes, dirty, gummed, or burned commutator, weak brush tension, or other causes of poor brush-to-commutator contact. Check all leads for loose or broken wires, terminals, or screws. If the above checks O.K., continue the tests by utilizing a conventional test lamp (see diagram) to locate open circuits or grounds in the generator in the following manner:

To check for ground, raise the grounded brush and insulate it from the commutator by means of cardboard. Then touch one of the test points to the main brush lead and the other to the generator frame. If the lamp lights, indicating a ground, insulate the other brushes and check the insulated brush holders, commutator, and fields to locate the ground. If a grounded field is found, the output-regulating device should be inspected, because a grounded field will permit an excessive field current which may cause the regulator contact points to burn.

If the generator does not show a ground, check the field for an open circuit. Test for a shorted field by connecting a 6-volt battery and an ammeter in series with the field, and note the current draw. Use care in this test, as a shorted field will draw high current and cause damage to the ammeter. If a shorted field is found, it will probably be necessary to clean or replace the contact points of the regulator, besides replacing field coils.

If unsteady or low generator output is indicated on the ammeter, check the drive-belt tension and brush tension. Be sure the brushes are free in their holders, making free contact with the commutator.

If generator output is excessive, it usually indicates an improperly set regulator. If the generator is of the third-brush type, which is not equipped with an external regulator, this condition is very likely due to an incorrect third-brush setting.

When a generator is noisy, the trouble usually can be attributed to a loose mounting or drive pulley, worn or dirty bearings, improperly seated brushes, or a bent brush holder.

While your generator is disassembled, its parts may be tested separately. The illustrations show the correct procedure.

What a driver sees in the visual-efficiency "dimometer"—a dim-out street with parked cars and moving pedestrians. At the left, Dr. Charles C. Hawkins explains his device

Ingenious New Tests Reveal Unsuspected Hazards in Wartime Motoring and Pose the Question . . .

Are You Fit to Drive in a

Don'ts for Drivers

DON'T relax alertness for one instant.
DON'T drive more than 20 miles an hour.
DON'T start driving for five minutes after leaving a brightly lighted place.
DON'T attempt to beat traffic lights.
DON'T leave proper lane on highways.
DON'T drive if you have been drinking.
DON'T make sudden starts or turns.
DON'T take anything for granted.

Don'ts for Pedestrians

DON'T cross against traffic lights.
DON'T cross except at crosswalks.
DON'T step into a street from behind either parked or moving vehicles.
DON'T walk in dim-out areas without wearing or carrying something white.
DON'T take it for granted that you are seen by an approaching driver.
DON'T attempt to judge the speed of an oncoming car.

ONE rainy night last December a big black sedan swung off Fifth Avenue in New York City and purred along a semi-darkened crosstown street. Suddenly a dim shadow darted before it. Too late, the driver saw the figure directly in his path. Shrieking rubber drowned all other sounds. When the car stopped, behind it lay the eighth pedestrian killed that night in the city's wartime dim-out.

Who is to blame for such needless deaths —the drivers or the victims? Why the increase in traffic fatalities now, when fewer cars are abroad? And what is being done to prevent these tragedies in the country's largest city and in other coastal areas where reduced lighting is a wartime "must"?

Most of the answers are yours for the asking. Specialists at the Center for Safety Education, New York University, have been tackling the problem of dim-out driving since the time it claimed its first victim. They are doing a thorough job of research and experiment to set up a basis for a nationwide educational program to prevent pedestrian accidents. Their tools are science, psychology, and common sense. Some of their testing equipment is unique.

Out of the research department at the

The inspector shown above is using a lighted adaptometer to test the ability of a driver's eyes to adapt themselves to dim-out streets after having been exposed to bright lights

In the photograph at right above, the weird instrument is a perimeter, used to show that a driver's side vision is almost zero when his eyes are focused straight ahead of him

Lower right, a test for such eyesight faults as color blindness, myopia, and astigmatism. A portable projector throws test charts on a miniature screen ten feet from the subject

Dim-Out?

N.Y.U. Center has emerged an instrument to test visual efficiency in the dim-out, appropriately named a "dimometer." If your vision is good, you see on a miniature city street four parked automobiles and five moving pedestrians who at first are concealed in shadows. If you fail to report the pedestrians, who are caused to cross the street by the operator of the instrument, you have technically run them down.

A high police official was embarrassed when he discovered he had "hit" two pedestrians in the dimometer test. Perfect scores were made by only a few of the more than 1,000 drivers of essential vehicles tested. One was a woman driver for the A.W.V.S.

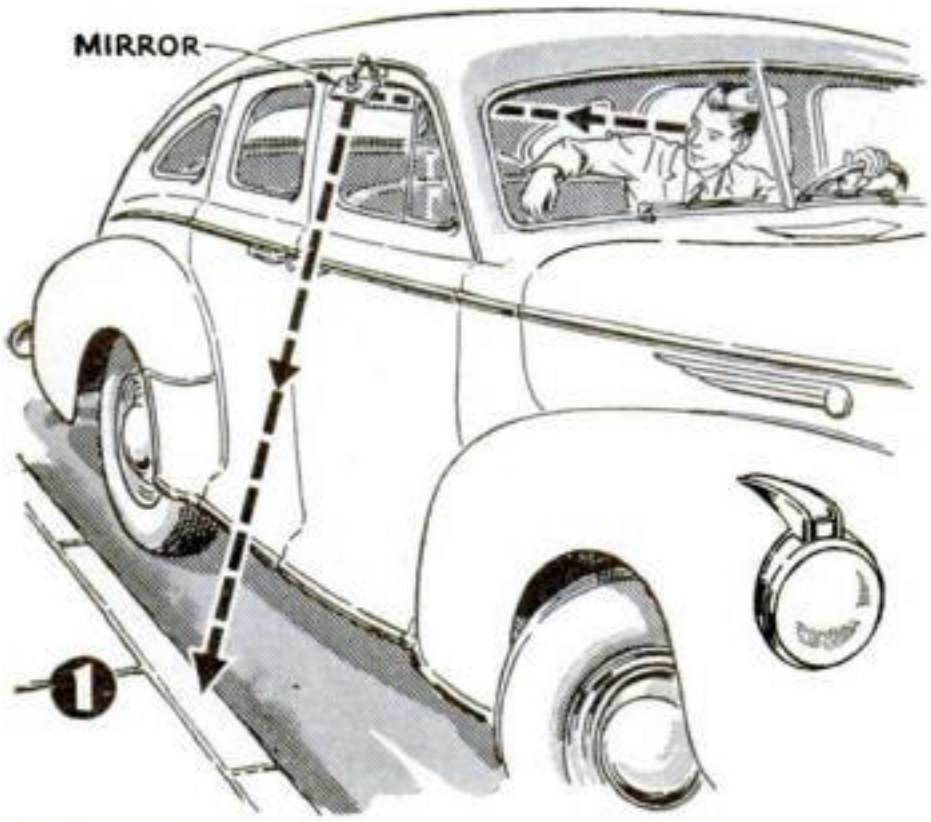
The Center uses an AO Project-O-Chart to test actual sight and to detect such faults in vision as color blindness and astigmatism. It employs a perimeter to measure the extent of side vision and to test ability to see on both sides while looking straight ahead. A phorometer tests the muscle balance of eyes, and an adaptometer ascertains the degree of night blindness.

In the dim-out, a driver loses 40 to 60 percent of his visual efficiency, and his side vision is reduced practically to zero, but his ability to see is doubled if he constantly shifts his glance from roadway to sidewalk. The danger zone ahead of a vehicle going 20 miles an hour is about 40'.

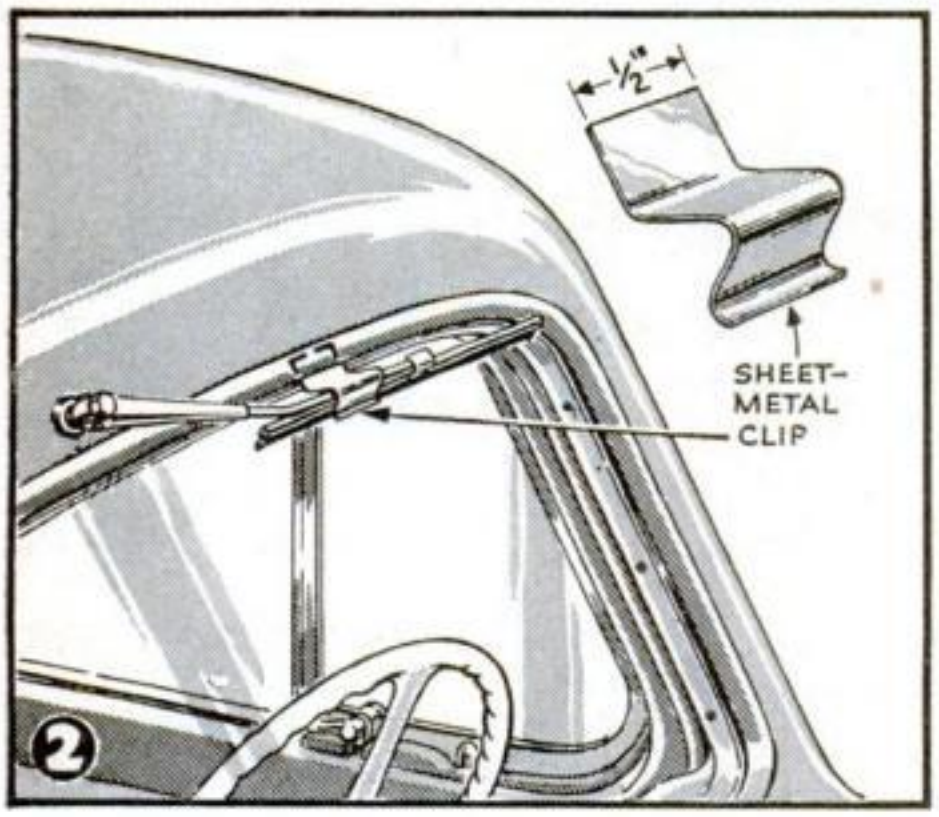
Pedestrians see approaching vehicles by spotting their dimmed headlights, but cannot judge their speed with any correctness. The average pedestrian, because he sees the vehicle, continues to conduct himself as though the driver can see him as well, but this is definitely not the case. The ability to see persons on foot, as far as drivers are concerned, is very poor. It can be increased markedly if something white—an arm band, for instance—is worn by the pedestrian. White serves to reflect the small amount of light present in a dim-out.

Pedestrian fatalities in some dimmed-out cities have increased 50 and even 100 percent. In Greater New York, night-driving fatalities mounted from 370 in 1941 to 417 in 1942, while daytime fatalities dropped from 279 to 200. Experts thus reason that in that metropolitan area alone dim-out driving has killed 152 persons who otherwise would be alive today. Therefore the N.Y.U. Center urges all national and local safety organizations, motor-vehicle departments, and local police departments to combine their efforts in dim-out education.

IDEAS FOR MOTORISTS



1 PARKING IS SIMPLIFIED and damage to tire side walls prevented by a mirror on the right-hand car door. It is tilted to reflect the edge of the running board and curb line. A slight bend should be made in the mirror arm in order to place it below the rim of the door. Fit a setscrew to the ball socket so that the mirror may be locked in position after it is adjusted to the driver's line of vision.—C. L. B.

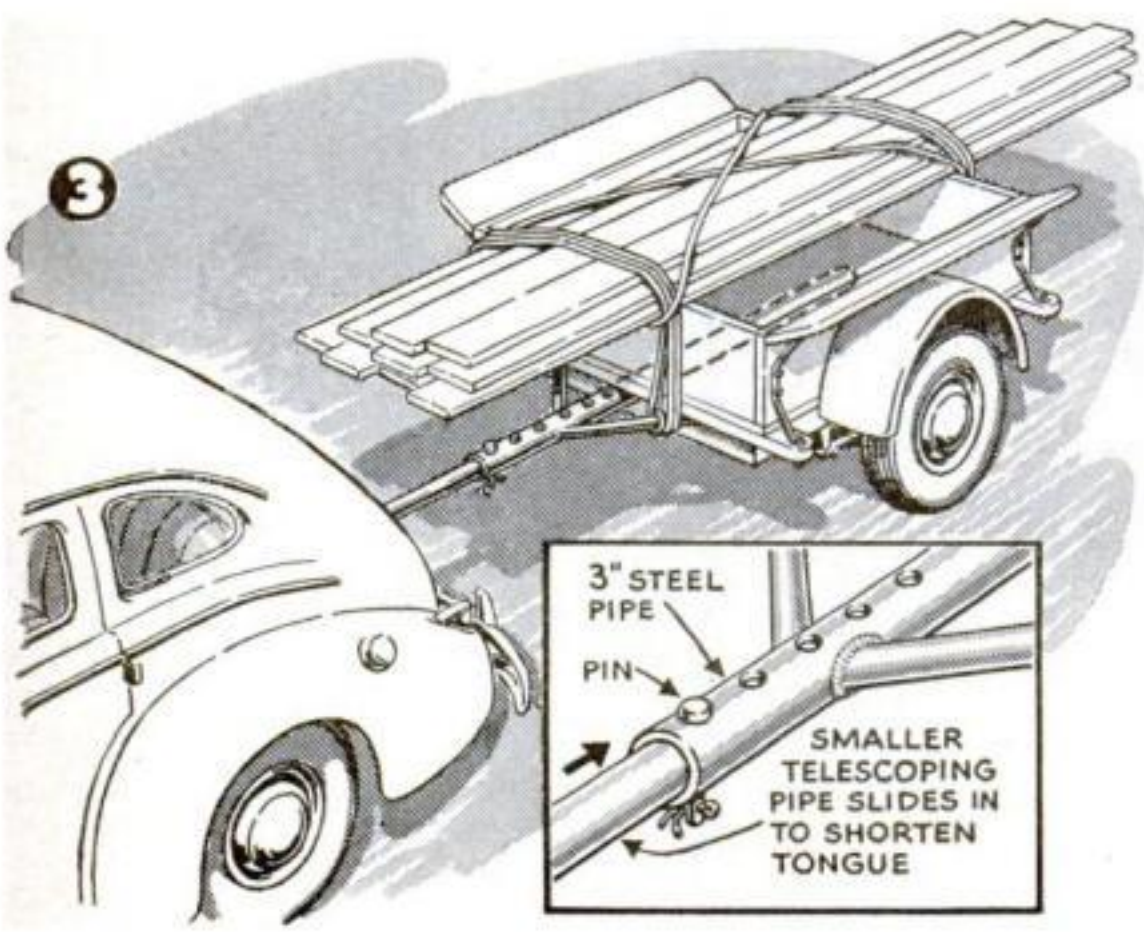


2 A WINDSHIELD WIPER that won't stay up can be held out of the way with a clip made of sheet metal or an annealed piece of clock spring. The clip should be bent as shown, and the flat end pushed or driven up between the glass and the windshield frame. Slip the arm of the blade under the clip when the wiper isn't needed.—A. H. W.

3 ADD TO YOUR TRAILER'S USEFULNESS by making a telescoping tongue of two pieces of pipe, one fitting into the other, as shown in the drawing at left below. Holes are bored into the pipes for a good-sized bolt, which serves as a locking pin. Such an arrangement will make your trailer more adaptable for hauling long objects.—A. H. W.

4 DIM-OUT DRIVING is a hazardous business. Here's a helpful hint that will be a boon to night drivers. Paint the rear edge of the driver's door solid white so that when the door is being opened the moving white strip will be seen by approaching cars.—D. H.

DRAWINGS BY STEWART ROUSE



Gus Helps the Army by Remote Control

By MARTIN BUNN

"Welcome home, Lieutenant Blake," said Gus to Harry

WHEN Harry Blake first came home on leave, we Model Garage regulars didn't know just how to treat him. Back before the war he'd taken a job as Gus Wilson's grease monkey a couple of weeks after graduating from high school, and naturally we older men had fallen into the habit of kidding him a good deal. As the years had drifted by and he had developed into a first-class mechanic, we hadn't changed our half friendly, half patronizing attitude toward him. Even when his National Guard regiment had been called into Federal service, we hadn't taken it very seriously.

But the afternoon not long ago that a few of us drifted into Gus's shop and found Harry Blake there, we realized that he wasn't the same old Harry. He had the kiddish grin we all remembered, but he also had the yellow, blue, and red triangular insignia of an armored division on his shoulder, the silver bar of a first lieutenant on his overseas cap, a couple of ribbons on his chest, and lines around the corners of his mouth that hadn't been there before.

Gus made a sort of introductory motion, and said without any kidding in his voice, "Lieutenant Blake—home on a month's leave after getting himself shot up in Africa." But when we asked about his adventures in Africa and how he got wounded, Harry just shut up like a scared clam.

A few afternoons after that we dropped into the Model Garage again and once more found Harry there. This time he looked more natural. His uniform coat was draped over the back of a chair. He had pulled an old pair of overalls over his pants. There was something wrong with Ez Zacharias's car, and he'd been helping Gus check it. Having just located the trouble, they were feeling pretty triumphant.

"That was a tough one," Harry said. "It was the toughest trouble-shooting job I've tackled since—since—"

"Since when?" Gus demanded.

"Well, since I was over there in North Africa," Harry said unwillingly. "I had a trouble-shooting job over there that had me on a spot, and Gus Wilson got me off it. I mean, his vision got me off it."

"Huh?" Gus said. "What the dickens do you mean—my vision?"

"Well, that's what it was," Harry insisted. "It's sort of a long story."

Gus gave him a push toward a chair. "You're going to tell it, even if it is," he said. "I've been called a lot of things in my time, but this is the first time I've ever been called a vision, and I want to know how come."

Harry sat down and lit a cigarette. "Well," he said. "It was this way. My armored division was attached to the British First Army when it went into Tunisia to try to capture Bizerte. This night I'm telling you about my tank company was in an assembly area a few miles from the burg they call Medjez-el-Bab.

"I was maintenance officer, and I had my section quartered on an abandoned Arab farm about a mile back from the rest of our outfit. The *Luftwaffe* was doing a lot of bombing, so everything had to be blacked out at night, but we had fixed up a barn with lights and blankets so we would be able to handle an emergency repair job if

"While the boys and I looked at the tube, I was secretly thanking my stars for Gus Wilson's vision!"

we had to. We were billeted in the farm house, which was close to the road.

"Well, about twelve o'clock that night I was sitting on my bedroll with my back against the wall, watching my sergeant and one of the men playing two-handed pinochle. I'd a lot rather have been in my bag asleep, but I had to guide a couple of trucks loaded with gasoline up to where our tanks were, and the trucks hadn't showed up yet. Pretty soon I heard the guard outside shout and a lot of loud talking in the road. Thinking that the gasoline trucks had showed up at last, I put on my slicker and started for the door. But before I got to it someone jerked it open, and three men came in.

"They were the three muddiest fellows I've ever seen. The first man in was the muddiest of them all. He was a big, beefy guy, and I could see that he was boiling mad. When he pulled off his trench coat, I saw that he had two stars on his shoulders. So I gave him a snappy salute. He returned it as though he hated to do it. 'You in command here?' he sort of snarled at me.

" 'Yes, sir,' I said, and told him my name and outfit.

" 'What are you doing back here?' he snapped. 'Why aren't you with your company?'

"I explained to him that I was maintenance officer, and that my section was at the farm because it was a better place for us to do our work than any we could find up with the tanks.

" 'Maintenance officer, hey?' he said. 'Know your job?'

" 'Yes, sir,' I told him.

" 'Know how to fix a Dodge pickup so it'll run?'

" 'Yes, sir,' I said.

"He sat down on a box and began to pick clods of mud off his pants. 'All right, lieutenant,' he said. 'Fix my pickup. And fix it *fast*. I'm in a hurry.'

" 'Yes, sir,' I said. 'What's the matter with your car, sir?'

"The general glared over at one of the men with him. 'Ask the sergeant there,' he said. 'He knows all about cars. He told me so himself, right after we broke down—the first time.'

"The sergeant's face reddened. 'Some trouble with the fuel line, sir—I guess,' he told me.

" 'You guess!' the general roared at him. 'You guess wrong just once more tonight and I'll take those stripes off your arm! Go with the lieutenant and tell him what you can about this dang-blasted crate of yours!'

"Well," Harry continued, "the sergeant

and I went outside. It was raining cats and dogs. A battery of guns was firing not far away. The sergeant sort of groaned. 'My God, sir, what a night'! he said.

" 'This isn't bad,' I told him. "The weather's too thick for bombing, and those guns aren't shooting our way.'

" 'Oh, it ain't the war I mean,' he said. 'It's the general . . . Say, lieutenant, we had to *push* that jalopy a mile to get here, and the general fell flat on his face *twice*. And I got to go on living with him!'

"My sergeant had routed out some of our fellows, and I told them to get my pickup and tow the general's, which was standing in the road, into the barn. I asked the staff sergeant what had happened the first time his car had quit on him.

" 'I dunno, sir,' he told me. 'We started out early this morning on one of the general's inspection trips. I told him the mud was so bad we'd better take a half-track, but he's a pigheaded old—excuse me, sir—I mean the general said to take the pickup. We didn't have any trouble all day. Along about sundown we were on a hill close to the front line, and some Fritz machine gunner spotted us and sent a burst so close that it spattered us with stones and mud. We went off that hill like a bat outa—well, fast. About half an hour after that the engine began to sputter. Then it quit dead.'

" 'Well, I figured first off that a bullet had punctured the fuel line and let water get in the gas somehow, but there wasn't any bullet hole. We had a five-gallon can of gas with us, so I drained the tank and the fuel-pump filter and put a couple gallons of fresh gas in the tank. When I stepped on the starter, she took off fine. After we'd gone for maybe five miles the engine stopped again. I drained the fuel line and the tank again, and put the rest of the gas in. She ran fine for a couple of miles. Then she sputtered and quit on me again. We didn't have any more gas, so there wasn't anything else I could do. Then the other officer—he's the general's aide—remembered that your outfit was up this way. So we pushed the old jalopy here.' "

Harry lighted another cigarette and looked around at us. "Wait a minute," Gus told him, and went into the office. He came back with a bottle of coke and handed it to Harry. "Fill up your fuel tank before you go on," he said. Harry grinned and took a long pull.

"We got the general's car into the barn," Harry went on, "and went to work. We checked the ignition, the spark plugs, and the wiring. They all were O. K. We drained the fuel-pump filter and tried the engine, but she wouldn't start. Then we cleaned out the carburetor and drained the gas tank. There wasn't any sign of water in the gasoline. There wasn't any hole in the tank or filter cup through which water could have been getting into the tank. The fuel line seemed perfectly tight. So we filled up the tank and stepped on the starter—and the engine took off and ran smoothly.

" 'That's got her, sir,' my sergeant said. 'I don't know what was the matter with her, but she's all right now.'

"So I said O. K. and started for the house to tell the general that his car was fixed. But I'd no sooner got out of the barn than I saw Gus Wilson's vision! We were working in the shop here, and I'd just finished a job, and he was telling me, 'Kid, getting a bus to run don't mean a thing if you don't know *why* you've got it to run. Don't ever let a job go out of this shop without *knowing* what caused the trouble in the first place. If you do, it's ten to one it will be back again, and the customer who brings it in won't be happy.'

"Gus's vision faded out then, and I realized that I was remembering something he'd told me when I first came to work for him. I went back into the barn. 'We're going to do some double checking on this job before it goes out,' I told the boys. 'Let's get at it.'

"We went over that fuel line inch by inch without finding anything wrong with it. The gasoline tank checked O. K. There is a kick-up in the frame over the rear axle. I felt along that fuel line one last time for luck. At the top of the kick-up, at the highest point of the fuel line, I found something. It was a hole—a little hole, but water from the wheel splashed up on the line at this point, and the hole let enough of it leak into the fuel to stop the engine!

"I thought of what the general would have done if I'd let that heap go out and it had stalled with him again, and believe me, I thanked Gus Wilson's vision! We replaced that tube with a new one, and I went in and told the general that his car was O. K.

" 'Sure of that?' he growled.

" 'Yes, sir," I said.

" 'You'd better be!' he snapped. 'Tell that fool sergeant of mine to get going!' "

For a moment after Harry finished nobody spoke.

"What I don't get," Ez Zacharias said at last, "is what made the hole in the fuel line."

"Well," Harry told him, "the staff sergeant and I figured that that machine-gun burst knocked up a stone that hit the fuel line over the rear axle and punched that hole in it. What do you think, Gus?"

"That probably was it," Gus said. "Harry, how about having dinner with me? I want to celebrate. After all, it isn't every night I get a general out of a jam in Africa by remote control!"

Over the top! Enthusiasm and agile muscles carry these boys over a wall on an obstacle course that toughens young bodies. Plans appear on a following page

Taking a 4' hurdle, one obstacle on a course scientifically designed to help make boys physically fit

JUNIOR Commando Course

OBSTACLES OF TYPE USED IN ARMY TRAINING ARE LAID OUT ON 100-YD. TRACK FOR TOUGHENING BOYS OF HIGH-SCHOOL AGE

HIGH-SCHOOL boys in many sections of the country are toughening up on junior commando courses similar to those used in the Army and at colleges to prepare soldiers and prospective soldiers for the rigors of battle. One such obstacle course, scientifically designed for boys of high-school age, is shown in the accompanying photographs and in the drawing on the following page. For comparison, a longer course used by soldiers in training at Fort Meade, Md., is shown on page HW 131.

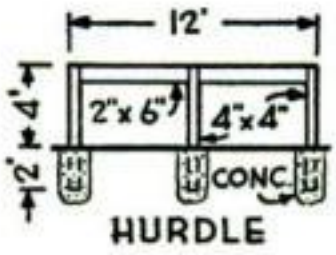
The junior commando course at which the accompanying action pictures were taken was worked out principally by John M. Rowley, secretary and general custodian of the Board of Recreation Commissioners, East Orange, N. J. It is 100 yds. long and has a series of five different types of obstacles intended to give a good, stiff workout to all of a boy's muscles, particularly to those that do not get full exercise during the average day's play. As an example of the speed at which the obstacles can be taken, the boy on the right in the photograph on the facing page and in the right foreground above was clocked when these pictures were shot, and he made the distance in 32 seconds, which is considered fast time. This will vary for boys of different ages.

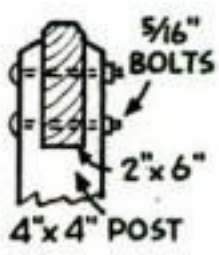
All obstacles are easily built of lumber that should not be difficult to obtain. The hurdle, scaling wall, and balance beams are set in concrete to the depths shown in the drawing, while the low bridge and the stakes in the stake maze are simply driven into the ground. In these two cases, where the moisture in the ground is apt to have a deteriorating effect on the lumber, the portions that are to be underground should be impregnated with creosote to prevent rotting.

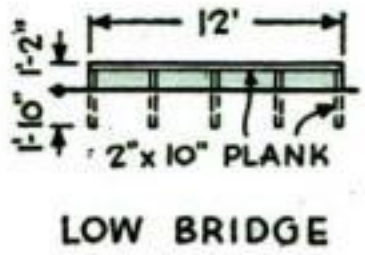
This course is built 12′ wide to accommodate four contestants at one time, and is laid on a 100-yd. straightaway, although

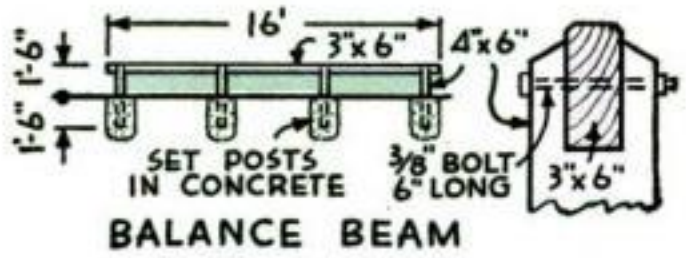
Stay on the beam! So goes the watchword for this balancing act not unlike a circus tightrope walker's

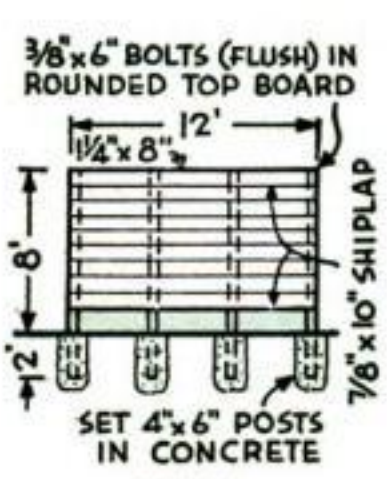
there is no reason why it should not be curved to conform to the land available. If this is done, care should be taken not to have the curves too sharp, or too close to such obstacles as the hurdle or scaling wall, for which a running start is necessary. Their own momentum might otherwise carry the contestants off the course. One place where a curve might naturally fit, if convenient in the layout, would be in the stake-

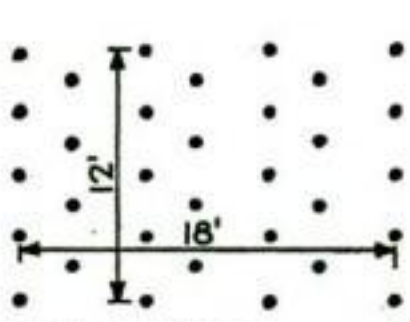












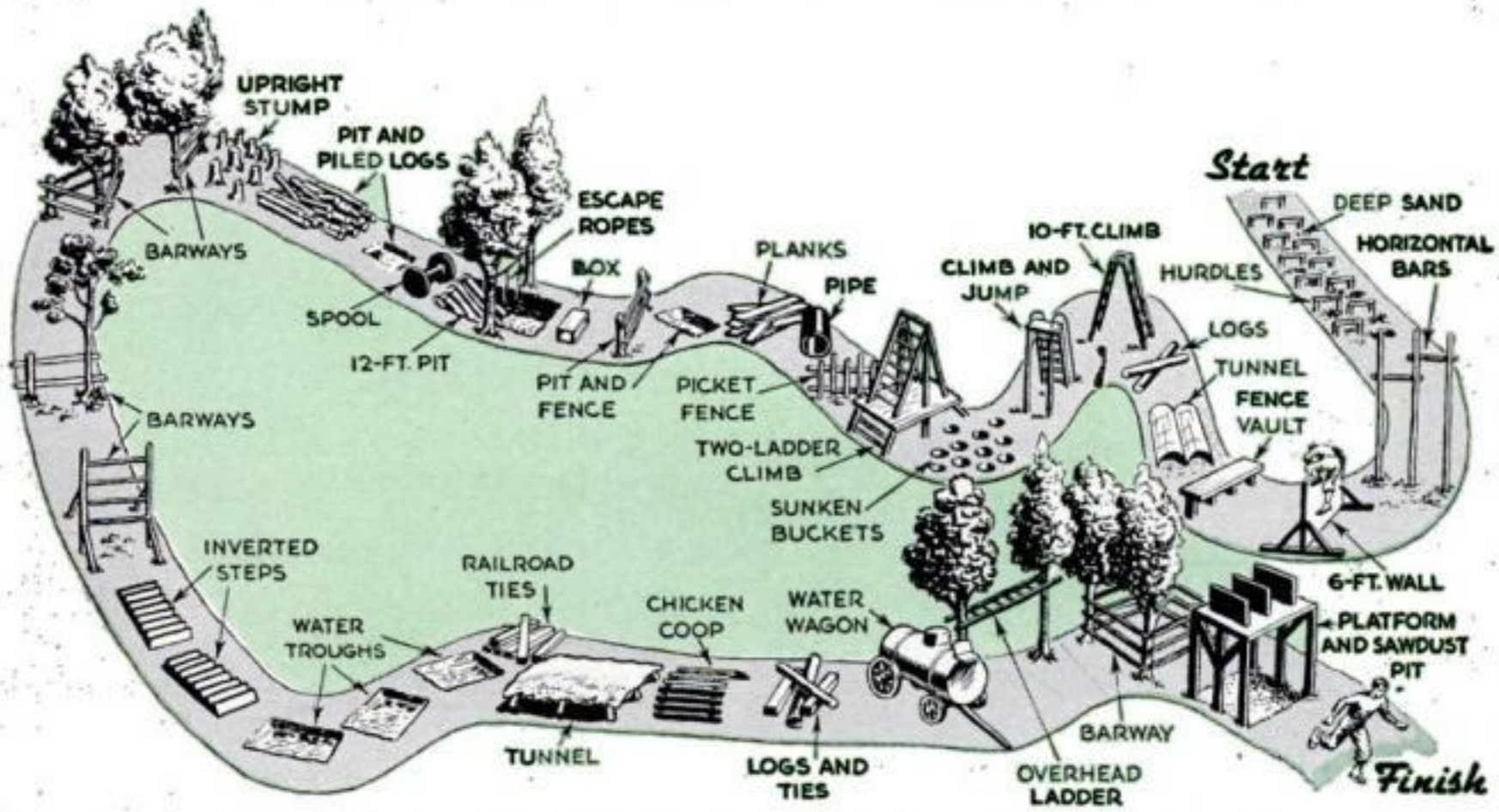
BILL OF MATERIALS		
1	2"x 6" - 12' LONG	FIR
4	4"x 6" - 10' LONG	FIR
4	3"x 6" - 16' LONG	FIR
4	4"x 6" - 12' LONG	FIR
3	4"x 4" - 6' LONG	FIR
5	2"x 10" - 12' LONG	FIR
8	1"x 10" SHIPLAP	12' LONG
1	1¼"x 8" - 12' LONG	WHITE PINE
32	7' POST - APPROX.	6" DIAMETER
BOLTS, NAILS, CEMENT, ETC.		

This low bridge is no place for fat boys, but few will have excess pounds if they train in this way

maze obstacle itself, for here the stakes are so staggered and are at such unequal intervals that a curve would not add materially to the difficulty of passage.

It is a good idea to have at least a 15-yd. straightaway before the opening hurdle, one of 19 yds. before the scaling wall, and an 18-yd. straightaway at the end so that the contestants, if not already winded, can finish with a burst of speed.

AND HERE IS HOW THE ARMY DOES IT



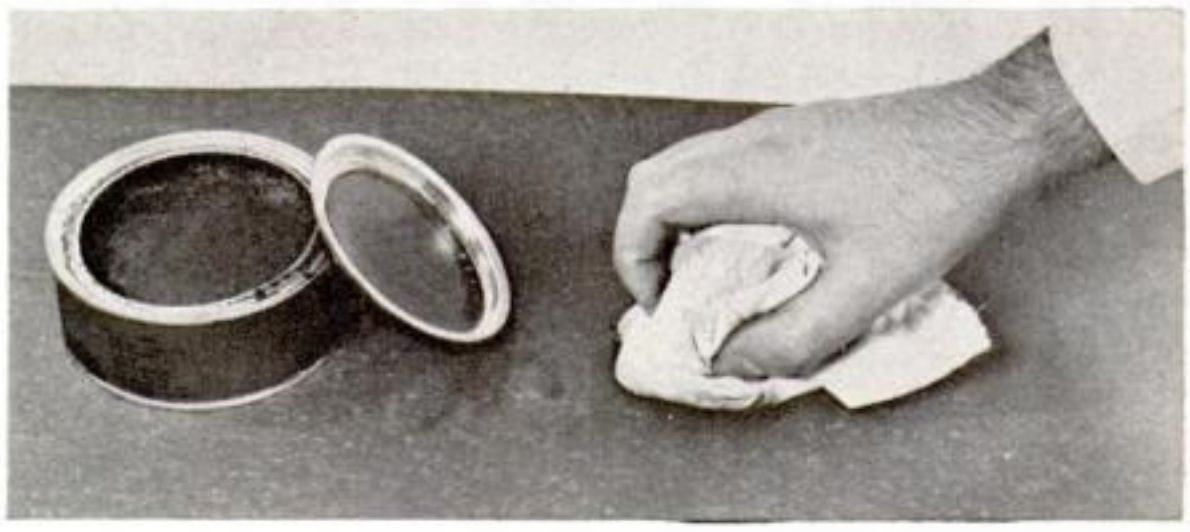
At Fort Meade, Md., this winding obstacle course is looked upon as "600 yds. of sore muscle." It is typical of toughening-up tracks for training Rangers and others in the Army to stand up under the rigors of battle. These obstacles will bring into play every muscle in a man's body

Adapted from *Yank*, the Army weekly. Original drawings by Privates Kraftsow and Ruge.

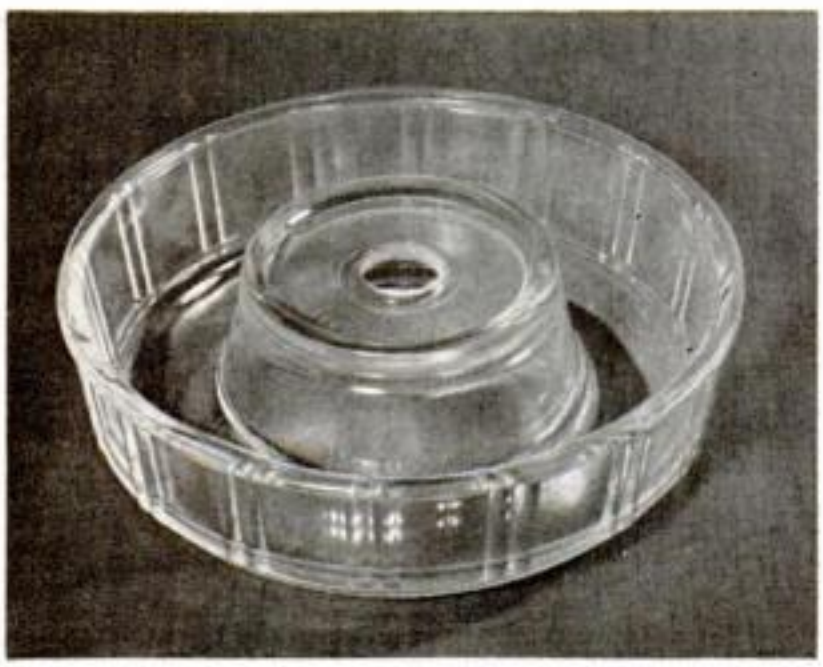
Housekeeping Aids

FOG ON MIRRORS can be prevented by applying a special new cream that spreads an invisible protective coating over the glass, causing all moisture to be dissipated. This cream is very convenient for shavers, for it does away with the annoying need of having to wipe off the shaving mirror several times when steam has collected there after the bath or shower. It can also be used to great advantage on kitchen windows, car windshields, and goggles. One application will keep the glass clear for approximately three to four weeks. The cream is put up in jars and comes in two handy 1-oz. and 4-oz. household sizes

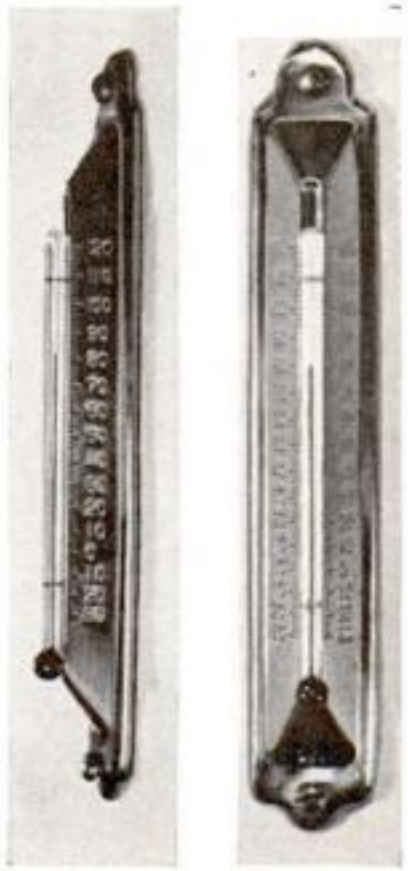
COLORED WAX is now available for use on linoleum. It comes in red, blue, green, black, and clear, and can also be used as a filler for areas which are scratched or scuffed. Some of the matching wax is placed on a clean, dry cloth and applied to the surface of the linoleum. After it has dried, the floor is polished. The same product can be used on bric-a-brac, or anything that requires a coat of wax



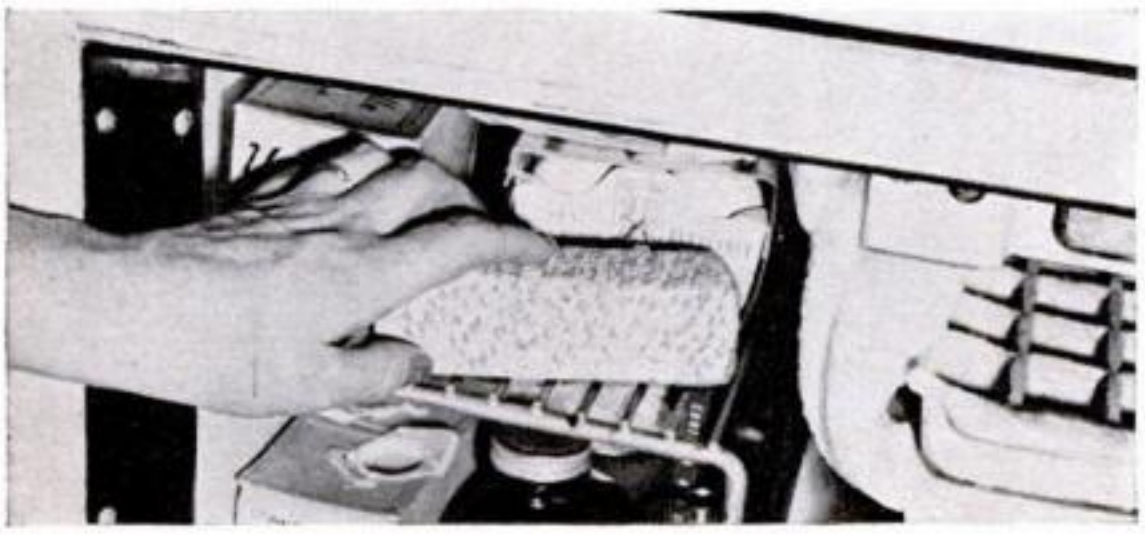
GLASS RING MOLDS now take the place of metal ones. Being ovenproof, they can be used in baking, as well as in molding gelatins, fruit desserts, and the like. A hole in the center enables one to get a strong grip when the mold is to be inverted. It measures 8¾" in diameter. The inside ring is 4" in diameter



THIS THERMOMETER is easy to read from any angle—left, right, or head-on. Because of this side-view advantage, it can be placed outside a window and can be read very easily from the inside. It can also be used in the office or the car. Two models of this handy gadget are available. One is finished in brass and the other in glistening chrome. Each one is 5½" high



TWO NEW WOODEN GADGETS. Directly below, an ingenious all-wood hanger for skirts is shown. Constructed of plywood, it will not warp and is said to be exceptionally sturdy. The shoe rack at the right can be placed on the floor or hung on the closet door. Light in weight, it is made entirely of wood without the use of nails, screws, or any other metal parts. The rack comes knocked down, but with easy instructions for assembling. It will hold from six to nine pairs of men's or women's shoes



A REFRIGERATOR DEODORIZER that looks like pumice stone is shown at the left. It will eliminate the mingling of food odors, keep butter sweet and ice cubes fresh. The bar will revitalize itself if removed from the refrigerator while you are defrosting or cleaning. The chemical products it contains are of a type harmless to all foods and liquids. This deodorizer is said to last about one year if cared for as directed

PLASTIC POT CLEANERS to be used in place of steel wool and other types are now on the market. They are easy to clean after use and have an added advantage over metal cleaners in that they will never rust

FABRIC CLEANER. This fluid will remove grease spots and other stains harmlessly and efficiently. It can be used on glazed chintz, velvet, leather, and the like, and demoths the fabrics as they are cleaned

HANG YOUR IRON in this wall bracket, and it will be out of the way and safely removed from children. It is made of enameled metal, and has twenty glass balls against which the sole plate of the iron rests

For the Period Room...

CHEST AND SECRETARY CAN BE BUILT OF PINE OR MAPLE

By JOSEPH ARONSON

EARLY American furniture was both sturdy and functional, particularly the cupboards, desks, and chests. This especially attractive piece of furniture, made up of two separate parts to form a secretary suitable for living room, bedroom, library, or den, pleasingly adheres to its American heritage.

The desk section has the advantage of having its drop front firmly supported when open by the top of the chest section, although the drop projects out far enough to provide knee room and toe space.

Generous space is provided in the drawers for storage of clothing or other articles, depending on the use to which the piece is to be put, and pigeonhole compartments in the top hold writing equipment.

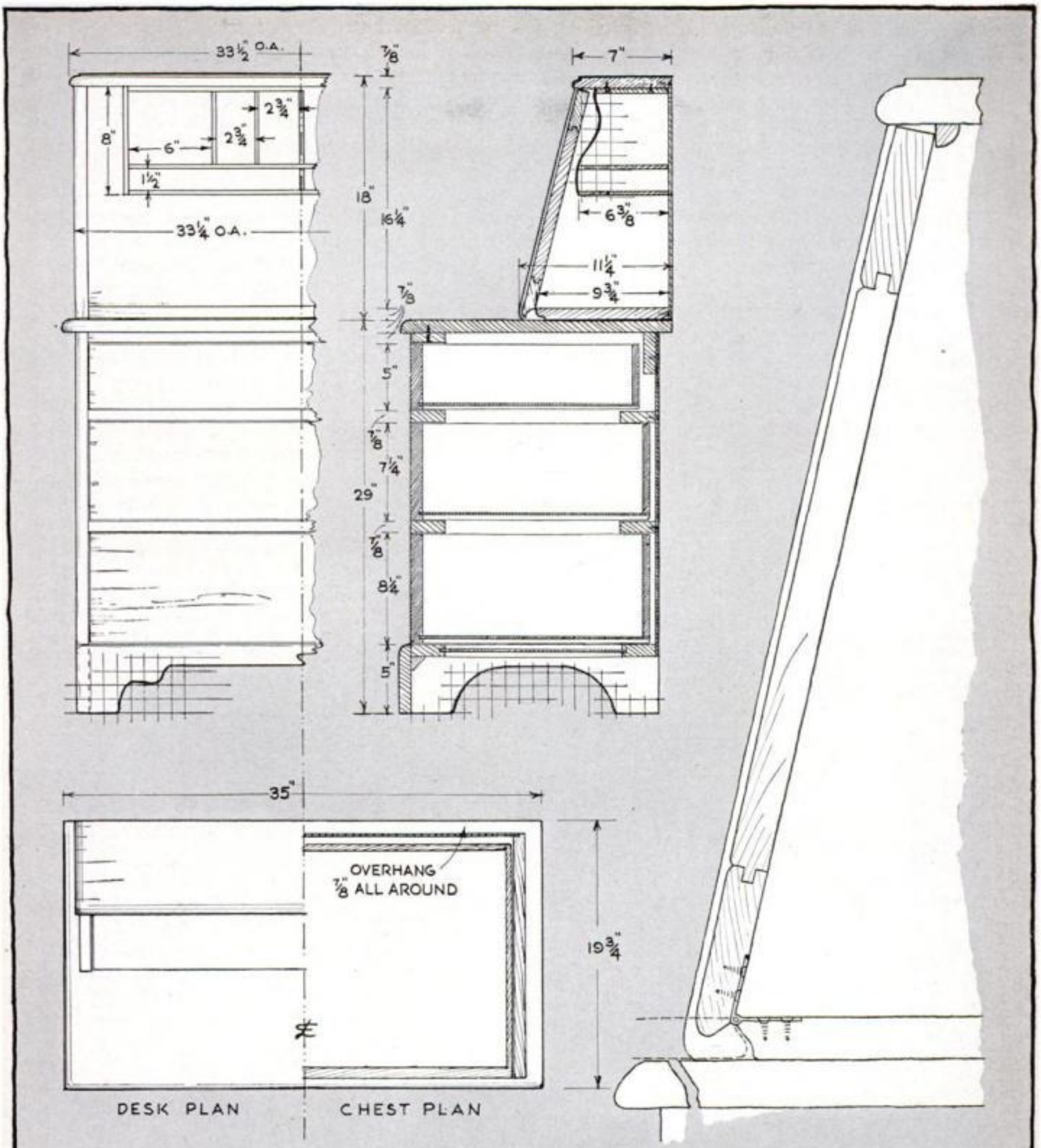
The construction of the chest unit is not difficult, although it takes accurate fitting. Solid lumber 7/8" thick was used for the most part. The secretary shown in the photograph was made of pine, but maple or another wood may be used. If the choice is a hardwood, which may not be fully 7/8" thick, the dimensions will vary somewhat.

After gluing up and preparing the top, sides, and drawer partitions, begin to form the case by doweling the frames into the sides. Note that only front and back rails and stretchers are glued to the sides. Side rails and cleats should be left free of the sides—that is, not glued—in order to permit the solid wood to expand and contract without cracking. The top back rail is set upright in order to stiffen the case.

Provide oversize screw holes all around the top stretchers and cleats, as the top of the chest should be held by screws passing through these holes to permit expansion of the solid top. The molding of the top is so simple that it can be planed off and sanded if no shaper is available. The base front member likewise is round-edged, and glued to the edges of the lowest rail and the ends of the sides. Secure this member further with small glue blocks under the lower front rail.

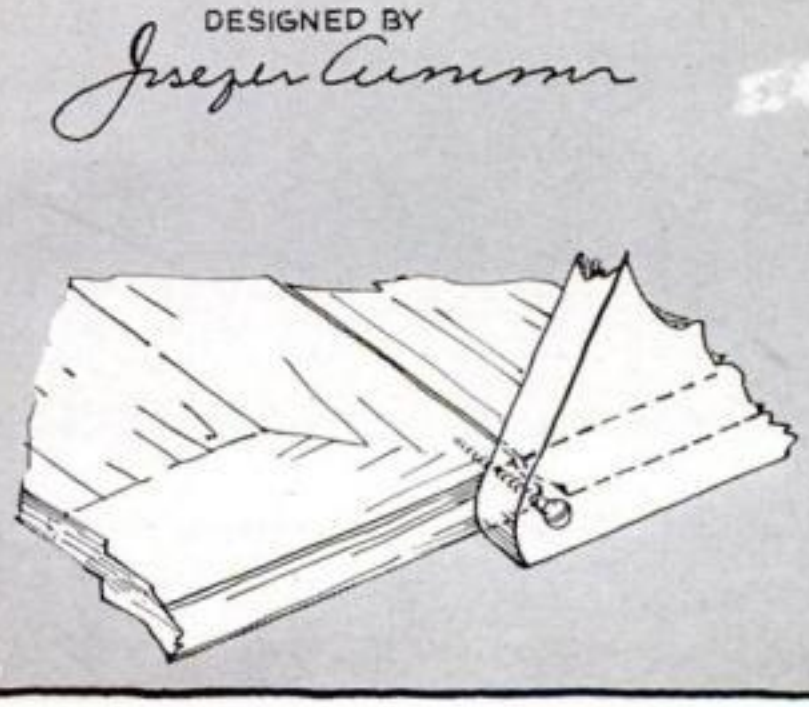
The drawers may be dovetailed or built with rabbet-and-dado joints. The dimensions given are for the latter type. In

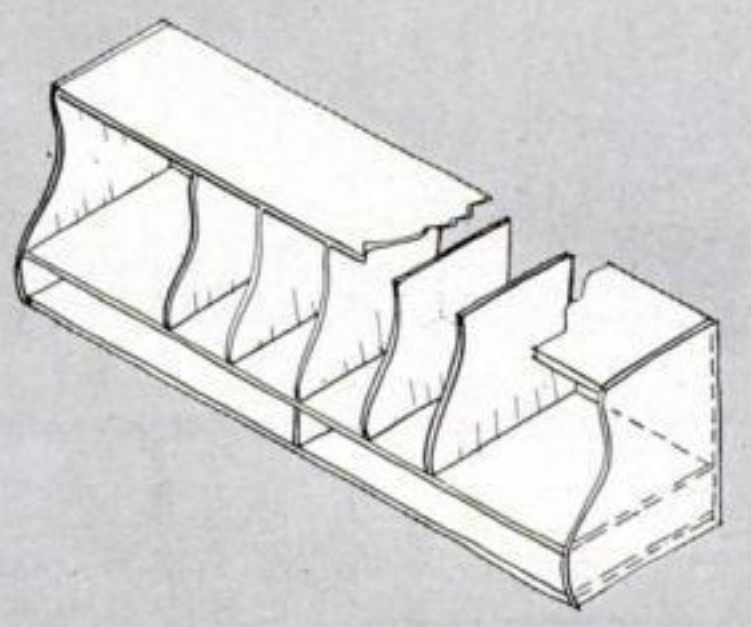
Handsome and sturdy, this serviceable desk is built in two sections. Construction details for the desk portion are shown in the drawing on the facing page. Note the knuckle joint at the hinge



DESIGNED BY

Joseph Aronson





either case, it is advisable to set the sides in about ⅛" from the drawer ends, providing the lower edges with guide strips about ⅛" by ¾". This prevents the whole side of a drawer from rubbing against the side of the chest, and permits closer fitting to obtain smooth-running drawers.

For the drawer bottoms and dust panel, use ¼" hardwood if plywood is not available. If authentic metal pulls are not to be had for drawer handles, use wood turnings instead.

Construction of the desk section is simple except for the fitting of the knuckle joint of the drop front. There is, of course, a visible slit along the bottom of the drop to provide space for the edge to turn. The drop may be a plywood panel in a mitered frame of 3" wide members, or else solid pieces similarly framed. A quarter-round molding under the top keeps the drop from closing too far. The hinges should be preferably of the type called desk butts, but if they are not available, the back-flap or table-flap type may be second choice. These butts leave a fairly flat surface when open, which it not true of the ordinary butt.

The stationery rack is made entirely of ⅜" plywood. It is built as a separate section and then screwed to the top of the desk. A few fine screws through the back into the shelves will help to strengthen the whole inner structure.

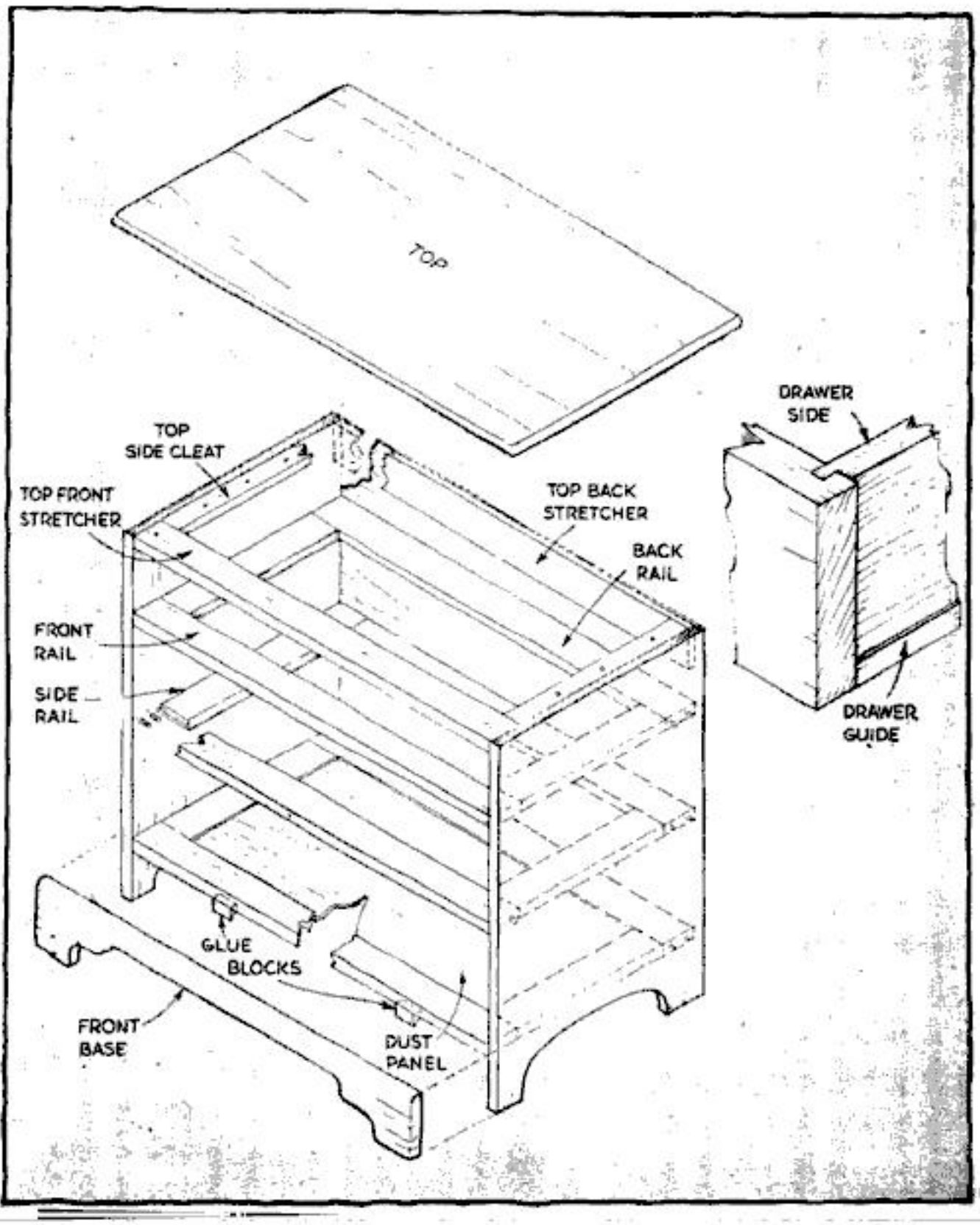
Finish the secretary so as to emphasize the grain. Sand carefully before staining, making all edges soft and nicely rounded. Use a light-oak water stain first, then a light coat of white shellac, well rubbed. Next, antique the surface with a glazing mixture of burnt umber in linseed oil. After this, apply another coat of white shellac and sand to a silky smoothness. A final finishing coat of hard wax will complete the job, and you will have produced an excellent piece of Early American furniture.

LIST OF MATERIALS

No. Pc.	Description DESK	T.	W.	L.
1	Top	⅞	7	33½
2	Sides	⅞	11¼	17⅛
1	Floor	⅞	9¾	31½
2	Lid frame	13/16	3	31½
2	" "	13/16	3	17⅜
1	" panel	13/16	12⅛	26¼
1	Back	¼	17½	33⅜
	PIGEONHOLES			
1	Top	⅜	5¼	25
2	Sheif and floor	⅜	6¾	25
5	Partitions	⅜	5⅜	6⅜
1	Partition	⅜	1½	6¾
2	Sides	⅜	6¾	8
	CHEST			
1	Top	⅞	19¾	35
2	Sides	⅞	18	28⅛
1	Back	¼	28⅛	32¾
1	Front base	⅞	5	33¼
1	Top front stretcher	⅞	2½	31½
1	Top back stretcher	⅞	3	31½
2	Top side cleats	⅞	2	15⅛
3	Front rails	⅞	2½	31½
3	Back rails	⅞	2½	31½
6	Side rails	⅞	2½	13
1	Dust panel	¼	13½	27
	TOP DRAWER			
1	Front	⅞	5	31½
2	Sides	½	5	16¼
1	Back	½	4½	30¾
1	Bottom	¼	16¼	30⅜
	MIDDLE DRAWER			
1	Front	⅞	7¼	31½
2	Sides	½	7¼	17
1	Back	½	6¾	30¾
1	Bottom	¼	17	30¾
	BOTTOM DRAWER			
1	Front	⅞	8¼	31½
2	Sides	½	8¼	17
1	Back	½	7¾	30¾
1	Bottom	¼	17	30¾

Note: All dimensions are given in inches

Both the front and back rails of the frames are doweled to the sides of the chest. Shown at the right below is a drawer joint



HW 136

Storage Bins for Garden Food Utilize Garage Wall Space

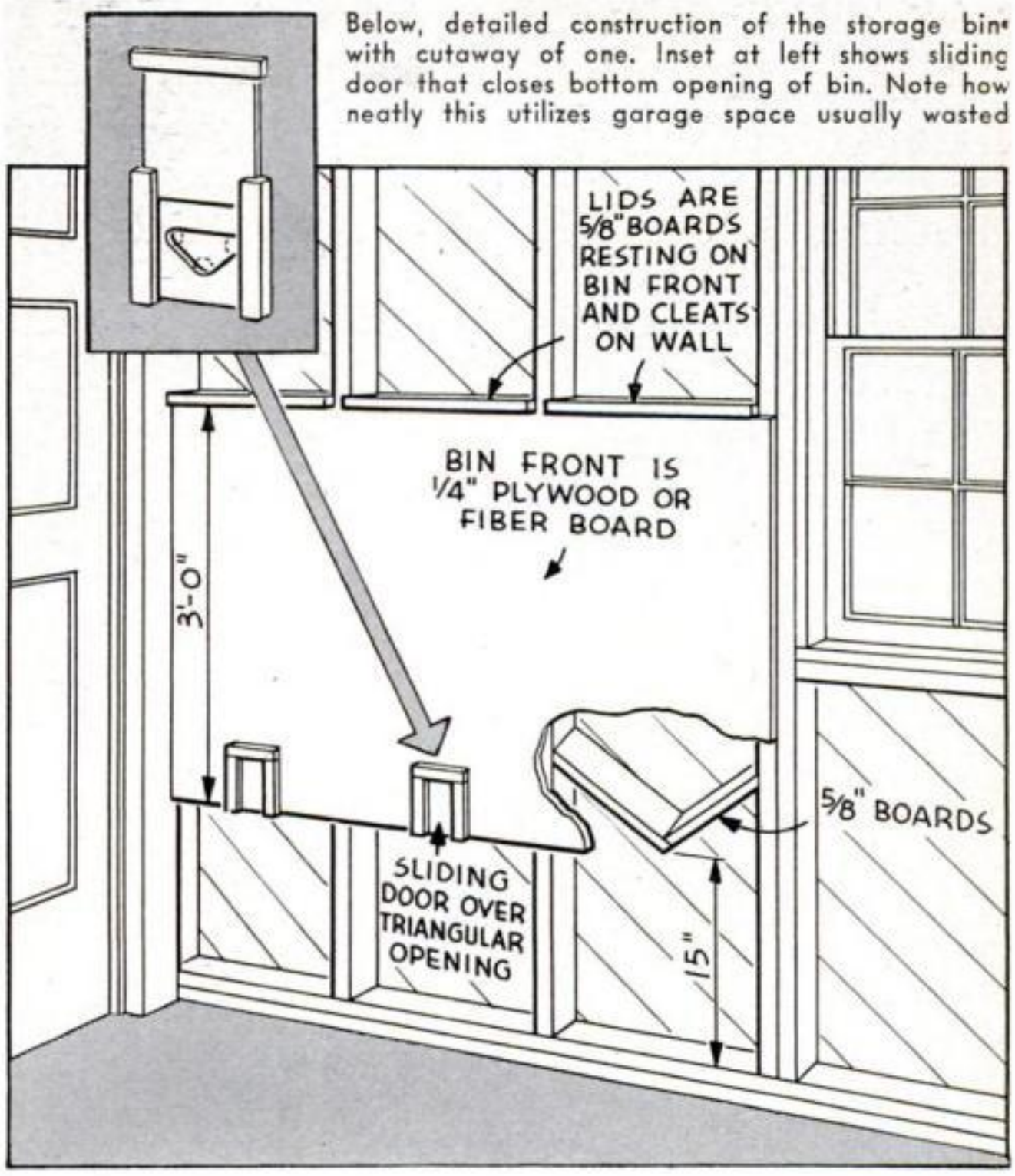
YOU can keep garden fertilizers and soil builders in space ordinarily wasted in the garage by building these storage bins.

Detailed dimensions are not given, because these may differ slightly for various types of garage construction. The bottoms of the bins are made from 5/8" stock and toenailed to the sheathing and studs at a slight angle. If the lowest point of the bottom is 15" from the floor, the spreader can be filled directly from the bin. The bin front is plywood or wallboard 3' high and as long as desired.

Make the hole at the bottom of each bin by first boring three 1" holes, and then cutting out the center.

The covers are boards resting on the front panel and on cleats nailed to the studs.—H.W. DRYDEN.

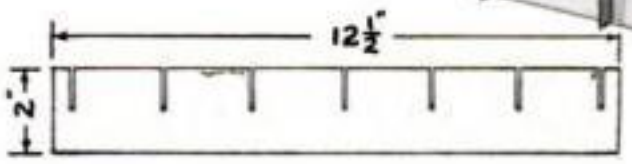
Below, detailed construction of the storage bins with cutaway of one. Inset at left shows sliding door that closes bottom opening of bin. Note how neatly this utilizes garage space usually wasted



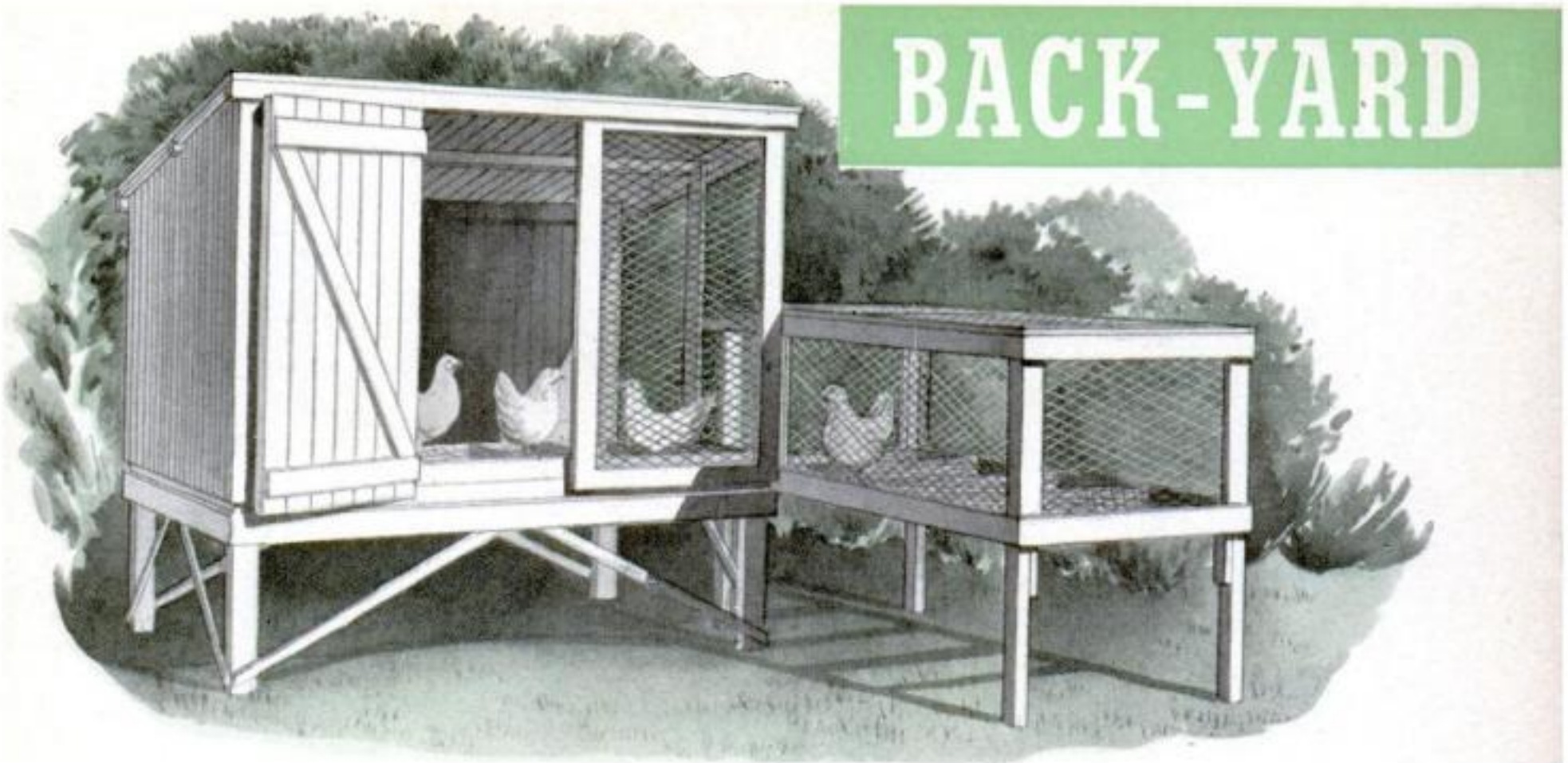
Seedlings Are Easily Transplanted from Egg-Crate Fillers

SEEDLINGS will withstand transplanting better if they are raised in the compartments of an egg-box filler. One seedling is placed in each compartment, and it is an easy matter to slide out the tender plants, each with its own cube of earth, without disturbing the roots or soil. If a larger size is desired, a 36-compartment filler from an egg crate can be used, or you can make one by cutting cardboard into 2" by 12½" strips and slitting them halfway through at intervals of 2". The strips are then fitted together to form the plant compartments. In making the flat, it is a good idea to have one side removable to aid in sliding out the plants more easily.—GEORGE MORASCH.

Seedlings set in egg-box fillers are easily transplanted. Wooden flat has been omitted for clarity



HW 137



BACK-YARD

Compact Hen Coop for a Small Flock Requires No Ground Runway and Can Readily Be Knocked Down for Easy Removal

TEN purebred laying hens will provide your family with an average of four eggs per day. It takes a comparatively small house to accommodate this many hens, and there is no need to provide a runway for them on the ground. The birds can be confined within a space of 5′ by 6′ plus an additional pen measuring approximately 2½′ by 6′, both areas 2′ above the ground. This coop was designed by the Agricultural Department of the University of California.

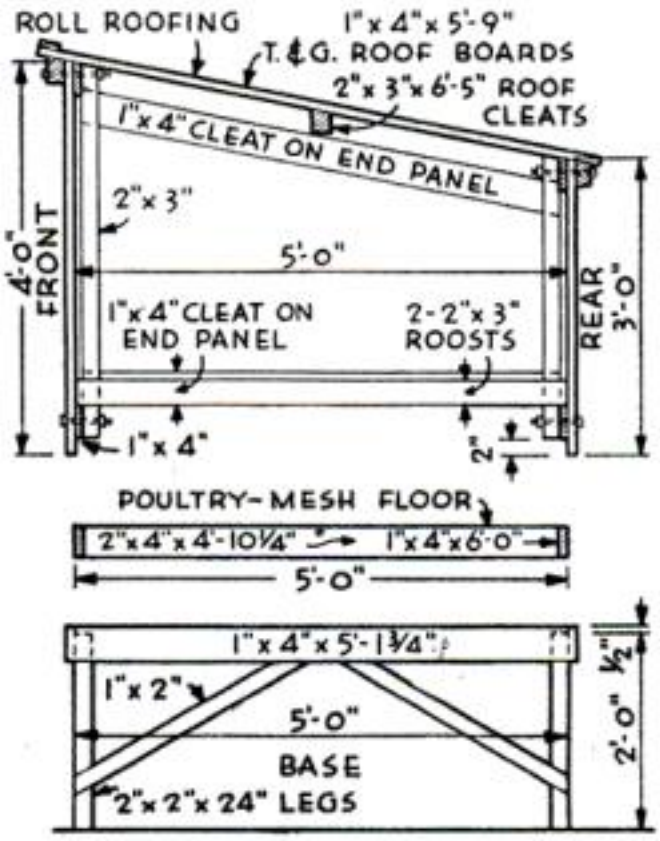
The floors of the house and pen are covered with wire mesh, which eliminates the need of using litter on the floors and also makes the cleaning away of droppings a simple and not too annoying job. With this task in large part eliminated, the small amount of time consumed in the care of a few hens is amply repaid by having fresh eggs during the present food emergency.

While it would be less work to nail up the hen house on a site, the plans show how it can be built in sections so that it can be put together and taken apart without harming the structure as a whole. This will allow it to be moved from one location to another as circumstances may require. The use of lumber dressed on four sides is recommended because better-fitting joints will result with less work. All dimensions on the plans, as given, assume that dressed 1″ lumber actually measures ⅞″ thick and that the dressed width is also correspondingly less. If the lumber you use varies from this, it will be advisable to check over-all dimensions before cutting pieces to length.

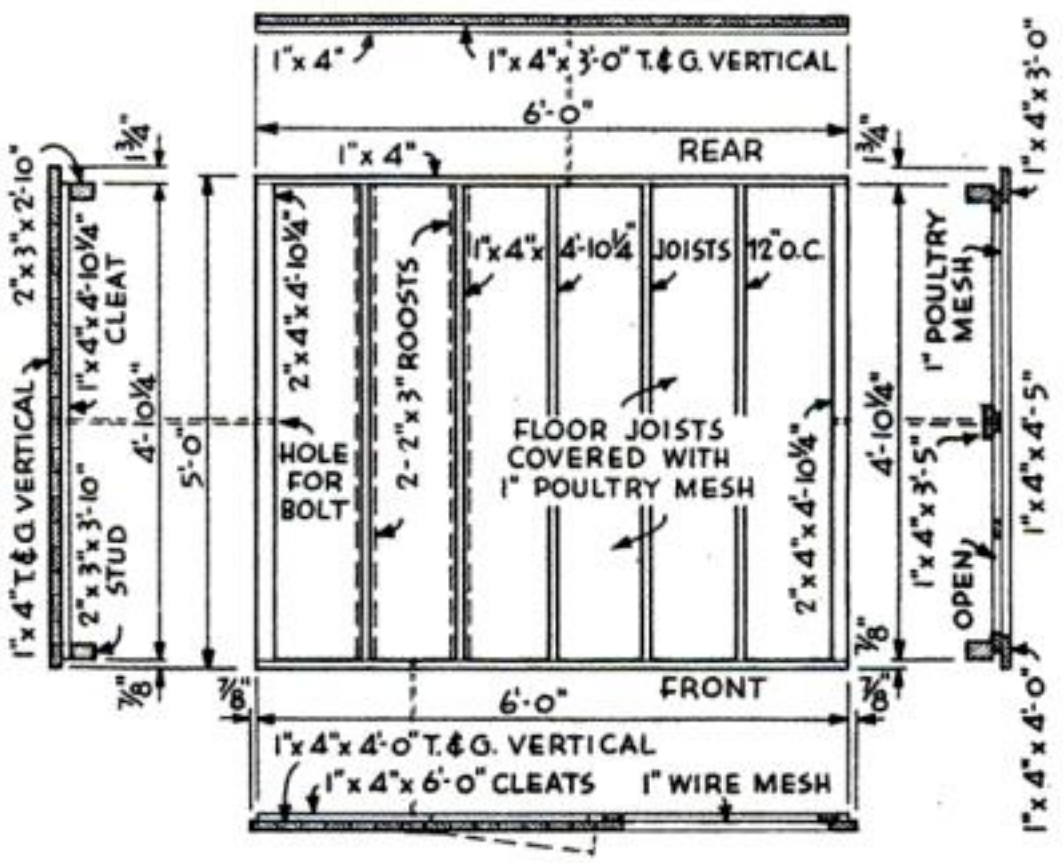
All open parts of the house are covered with 1″ wire mesh. If for any reason you are unable to get this size wire mesh at present, the use of wooden slats is recommended. Common lath will do for both floors and open sides of house and pen. Fasten the slats or lath on edge ¾″ apart for the floors, and for open wall panels put them flat and vertical, 1½″ apart. Face the hen house toward the south and put the open pen on the east end jutting out in front so the afternoon sun will reach it.

The hen house has a base, a floor section, four sides and a roof. The floor section fits into the top of the base, and the four sides are bolted to each other at the top and bottom corners, and also to the floor section on all sides midway between the corners. The sheathing for sides and roof is of 1″ by 4″ tongue-and-groove boards. Roof boards are nailed to three 2″ by 3″ cleats which extend about 2″ beyond the sides.

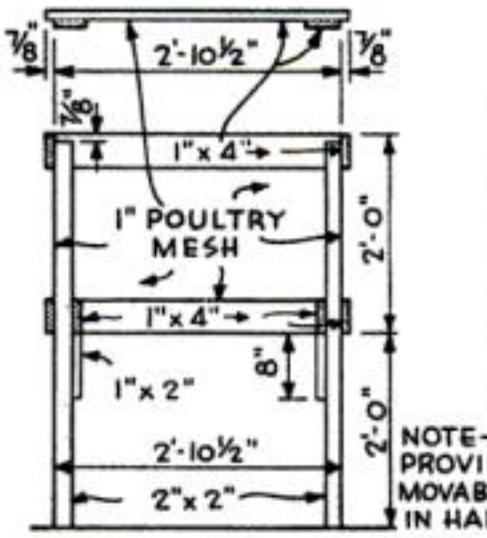
Equipment for the house includes a group of three nests, a feed hopper, and a box for grit and shells. The row of nests should be screwed to the west and south panels with the top of the nests touching the top rail on the west panel. Put a triangular slat frame on top of the nests to keep the birds from roosting there. A tumble reel, constructed as shown, will revolve and keep the hens from standing on top of the feed hopper, which is divided into two sections for mash and grain. The grit and shell hopper is hung on the north wall opposite the door, with the hopper mouth 6″ above the floor.

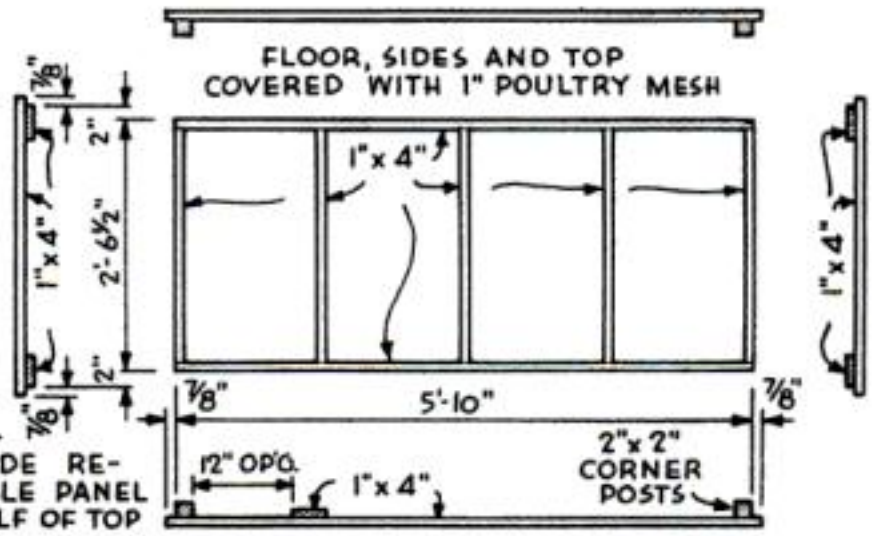


END VIEW



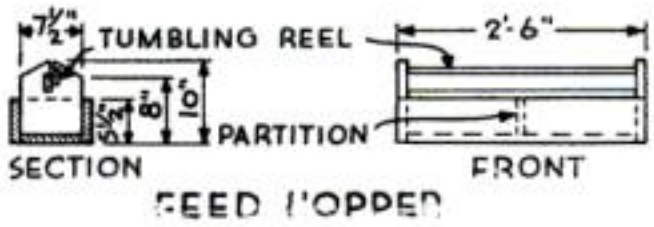
FLOOR PLAN AND SIDES



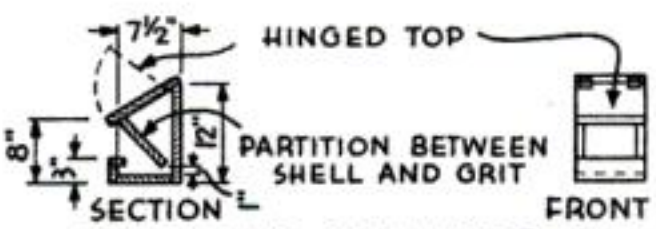


NOTE- PROVIDE REMOVABLE PANEL IN HALF OF TOP

END VIEW - SCREEN PEN - FLOOR & SIDES

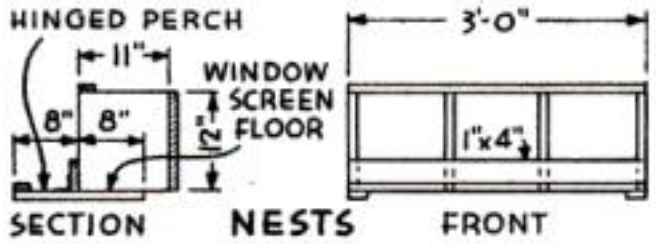


FEED HOPPER



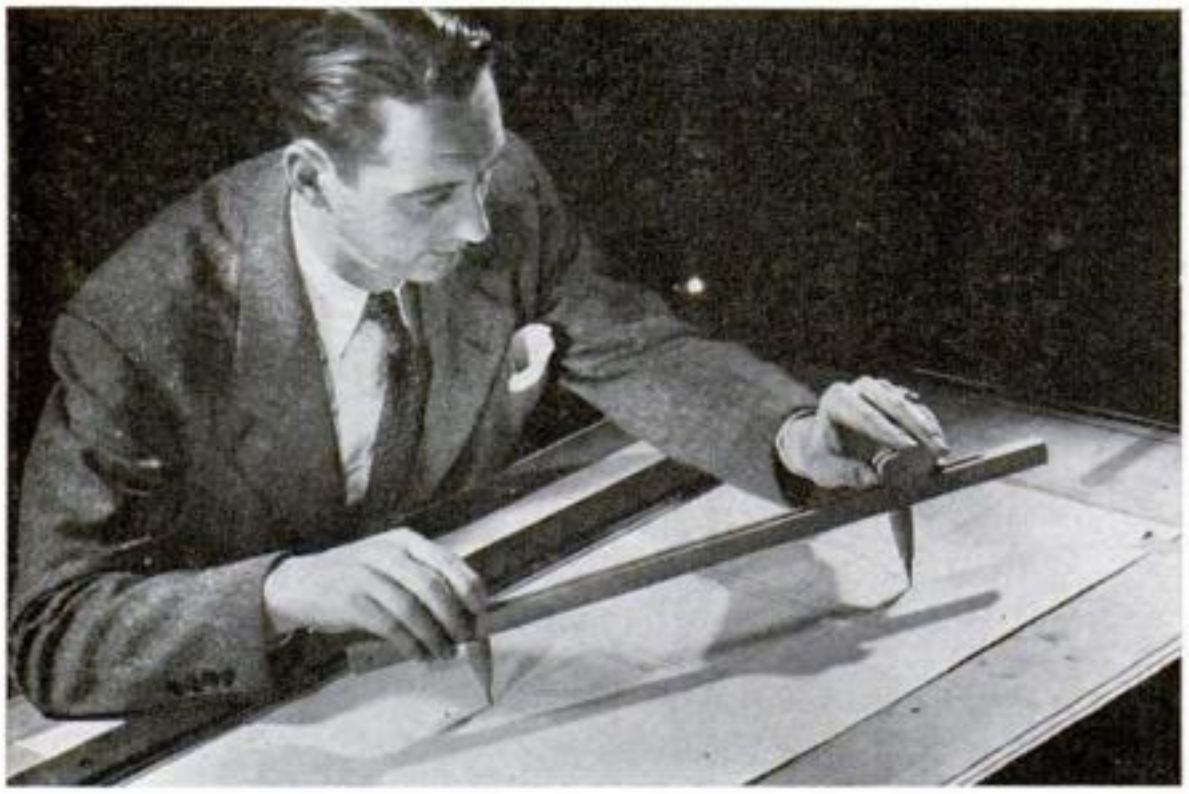
SHELL AND GRIT HOPPER

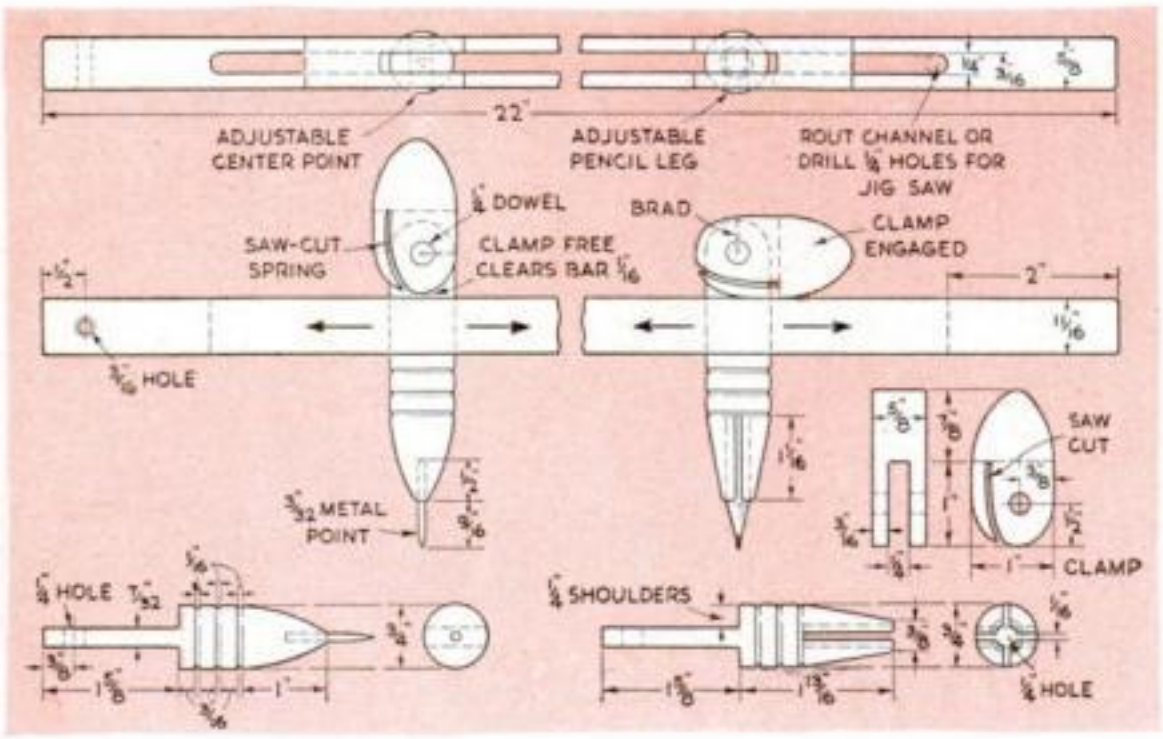
Dry ventilated quarters coupled with the right feed and clean water for laying hens will give maximum results in egg production. In severely cold or stormy weather the wire mesh of the house can be covered with burlap or muslin to keep the hens comfortable and in good health



NESTS

Craftwork Projects Hit Keynote





DESIGNED BY

ERNEST R. DEWALT

DRAFTING BEAM COMPASS. This all-maple compass, which has a bar ⅝" by 11/16" by 22", makes circles 34¾" in diameter on paper or plywood. It will prove much more convenient to use than a string on sticks or brads. The ¼" open channel, extending within 2" of either end, may be routed out or jigsawed from ¼" bored holes to gauged lines on opposite faces, and then sanded smooth.

Use ¾" maple dowel stock in turning the center point and pencil leg, allowing enough stock in the chuck on both pieces for 1⅝" tongues. Bore the holes for the metal point and the pencil in the lathe so they will be centered, taking the 3/32" hole to a depth of ½" and the ¼" hole to a depth of 11/16". Cut the slots and shoulders after finishing the lathe work.

Lay out the pivoted clamps on ⅝" by 1" maple stock, drill the ¼" holes, cut the spring line, and then cut out the open mortises and round the clamps to the shape shown. Assemble the clamps on the legs with dowels after trial fits, making certain that the springs engage the bar when pressed down and clear by 1/16" when upright. Then secure the dowels to the tongues with small brads. A hole may be bored at one end of the bar for use in hanging the compass on a wall.

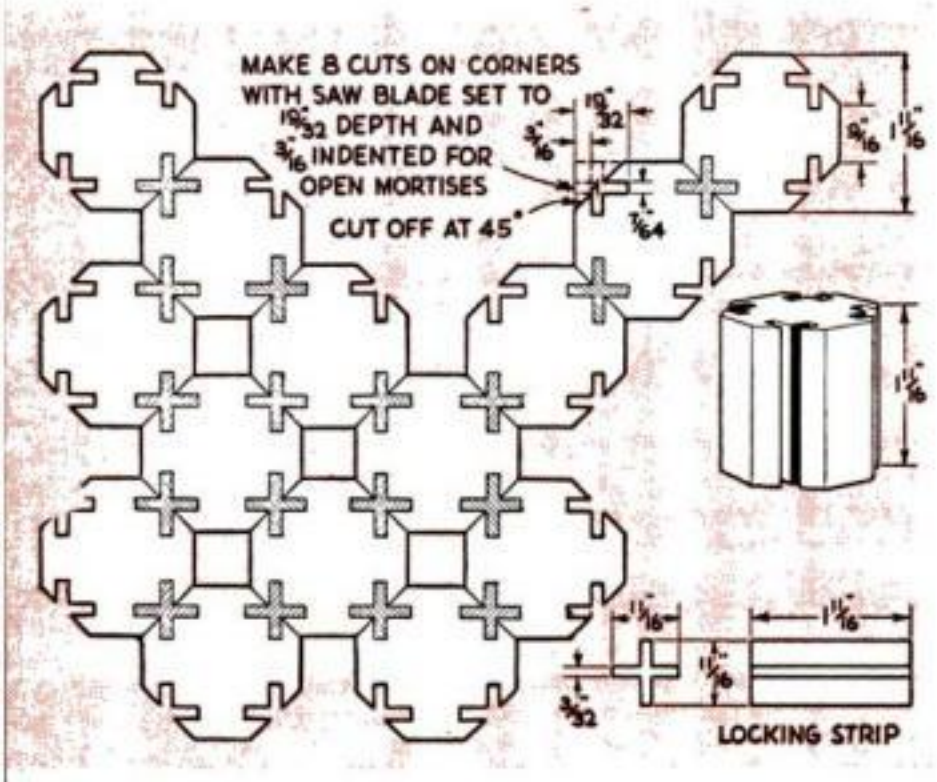
Sand and smooth all parts, taking special care that the inside of the channel is smooth enough for free sliding. Brush with two coats of lacquer. Working time, 4 hours.

LOCKING TOY BLOCKS. Here is a model-making construction set with a wide range of possibilities for the juvenile builder. The blocks will form horizontal and flat patterns, animal forms, three - dimensional figures and spirals, such as shown in the photograph. A minimum set should contain at least 24 blocks and 48 lock strips.

To make the blocks, cut 1¾" by 1¾" pine or whitewood into 4' lengths, or longer if the table of your saw will handle them. Then set the rip fence so single cuts 19/32" deep can be made 3/16" from each face for the entire length of the piece. Eight cuts are made in all, the two at each corner crossing as indicated in the drawing. The corners are cut off at a 45-deg. angle to produce eight faces, each one 9/16" wide. Cut the piece into 1¾" blocks and sand to 1 11/16".

Make the lock strips of 21/32" by 21/32" maple. Eight rip cuts, set in 9/32" with the blade 9/32" deep, are necessary to leave 3/32" fins. Use a sharp blade and make the corners clean so they will fit easily into the mortises of the blocks. Cut the lock strips 1 11/16" long plus 1/32" allowance for sanding the ends. While pine or whitewood is

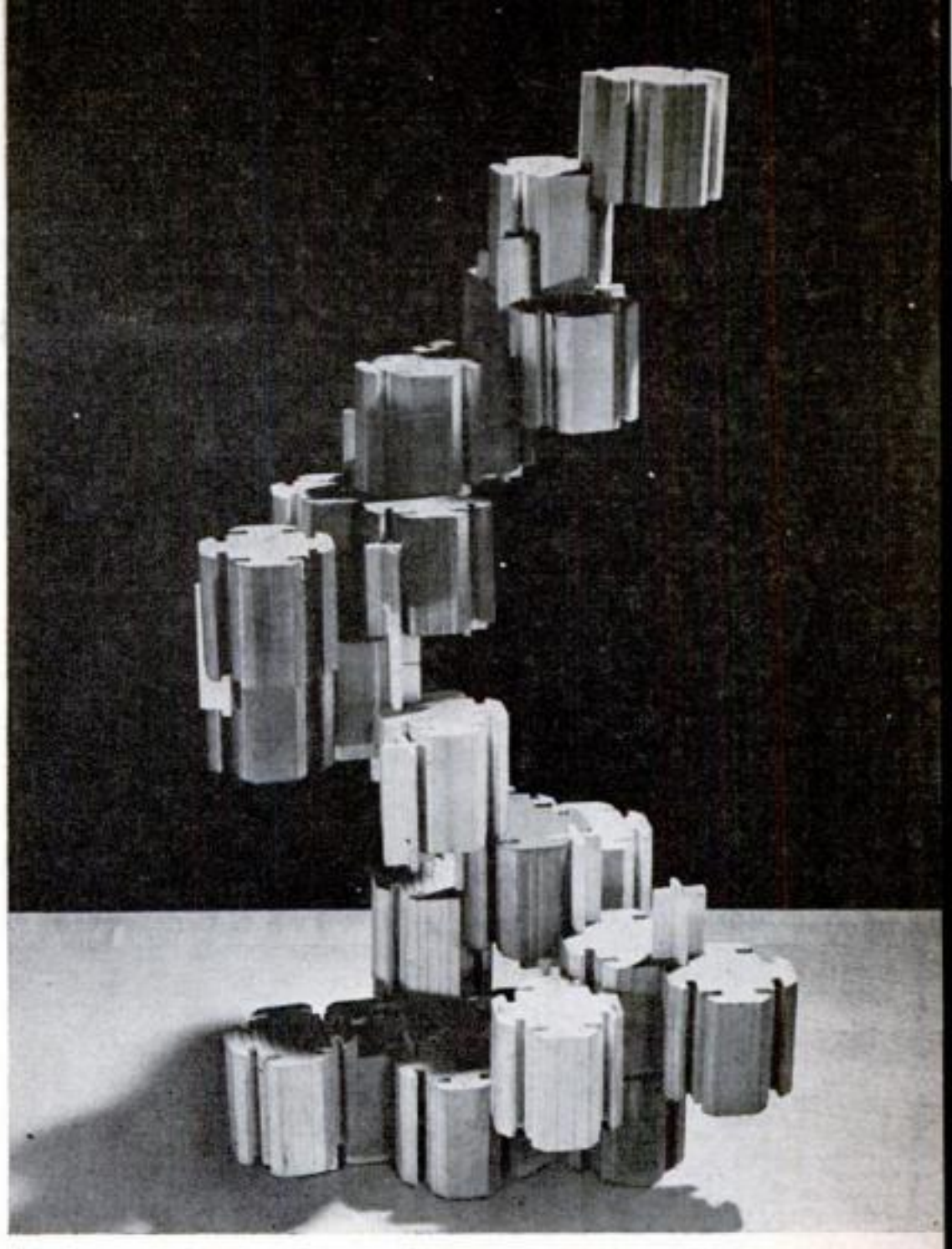
# of Ingenuity

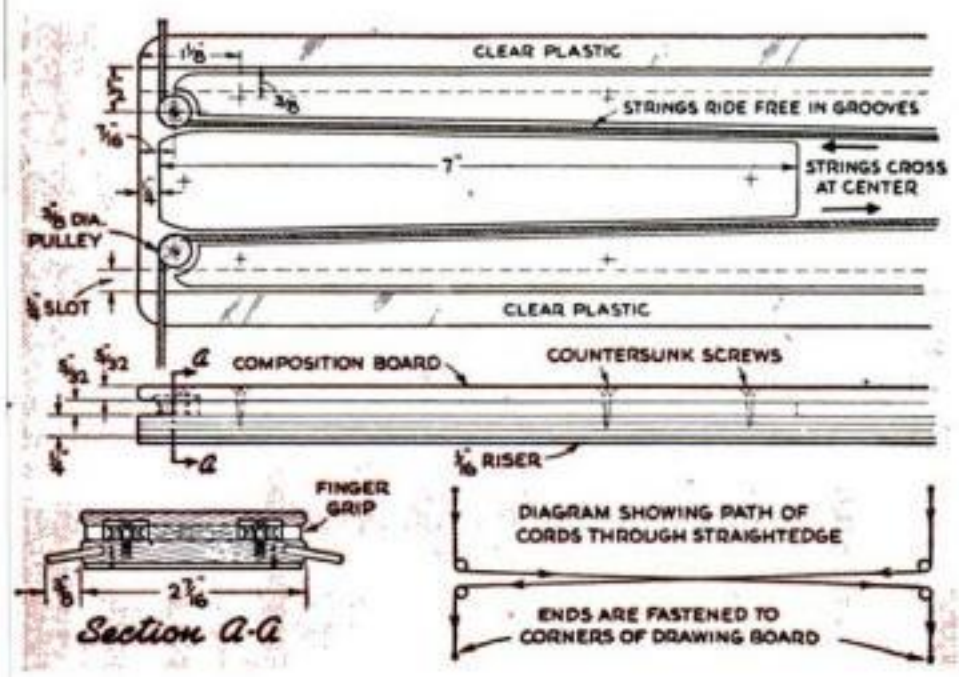


satisfactory, hardwood is more substantial. Working time, 4½ hours.

A PARALLEL STRAIGHTEDGE is set up permanently on the drawing board, its length being optional depending upon the width of the board. Seasoned pine or whitewood is used for the body. Saw slots at a 10-deg. angle ¼" deep to take the strips of 3/16" by ⅝" clear plastic. These are fastened in with cellulose cement. True the edges carefully with a steel straightedge and a sharp plane to be sure they are parallel, round the four corners, and smooth with fine sandpaper.

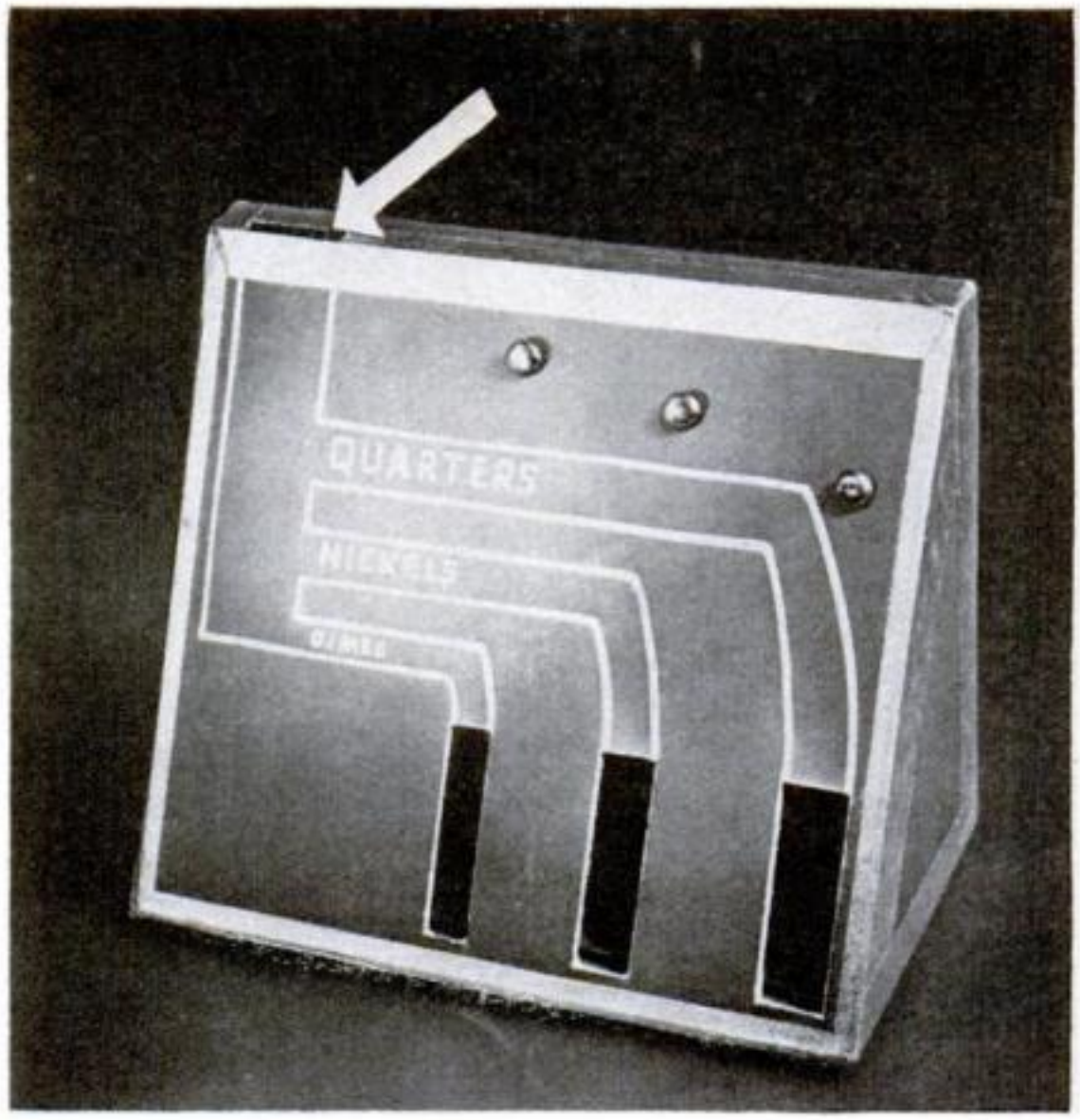
The fillers are of 3/32" tempered composition board, cut to permit clearance of the cords which work on the four pulleys. Leave room between the fillers for the cords to cross at the center. Run the cords on diagonally opposite pulleys, pull them taut, and then fasten the ends at the corners of the board. Finally, cover the filler with composition board. This may be in two parts, and should overlap the edges to form a finger grip. Sand the cover and finish with three coats of lacquer, rubbed between coats. Do not apply lacquer to the plastic. Neat fitting and careful finishing will produce a useful drafting accessory. It can be pushed to the top of the board when not needed. Working time, 4½ hours.





For War-Stamp Savings

NOVEL CARDBOARD BANK SEPARATES NICKELS, DIMES, AND QUARTERS

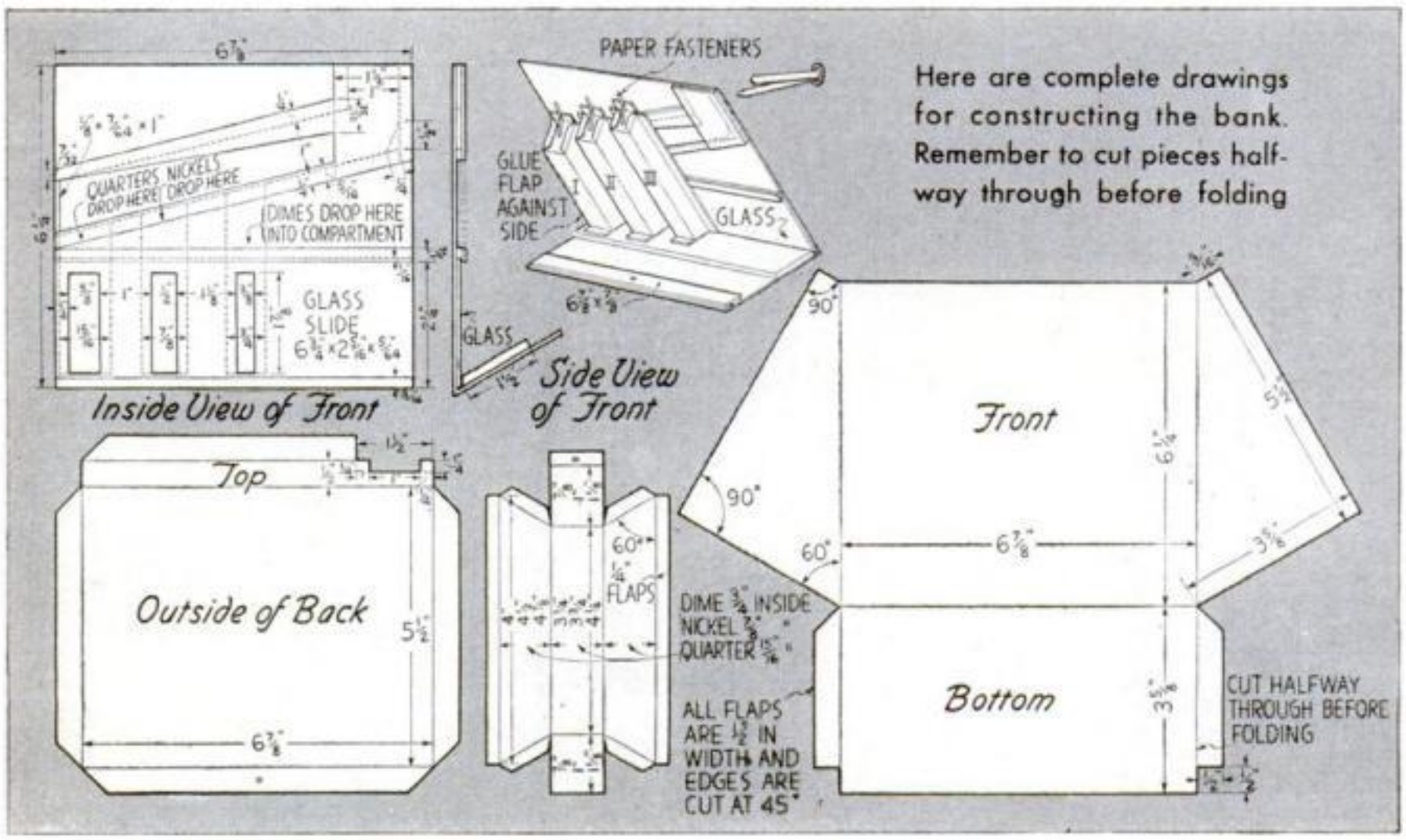


WATCH your War Stamp savings grow in this novel bank that automatically stacks nickels, dimes, and quarters in separate compartments as they are inserted through one slot at the top. Since the compartments are transparent, it is easy to see at a glance just how much money has been saved.

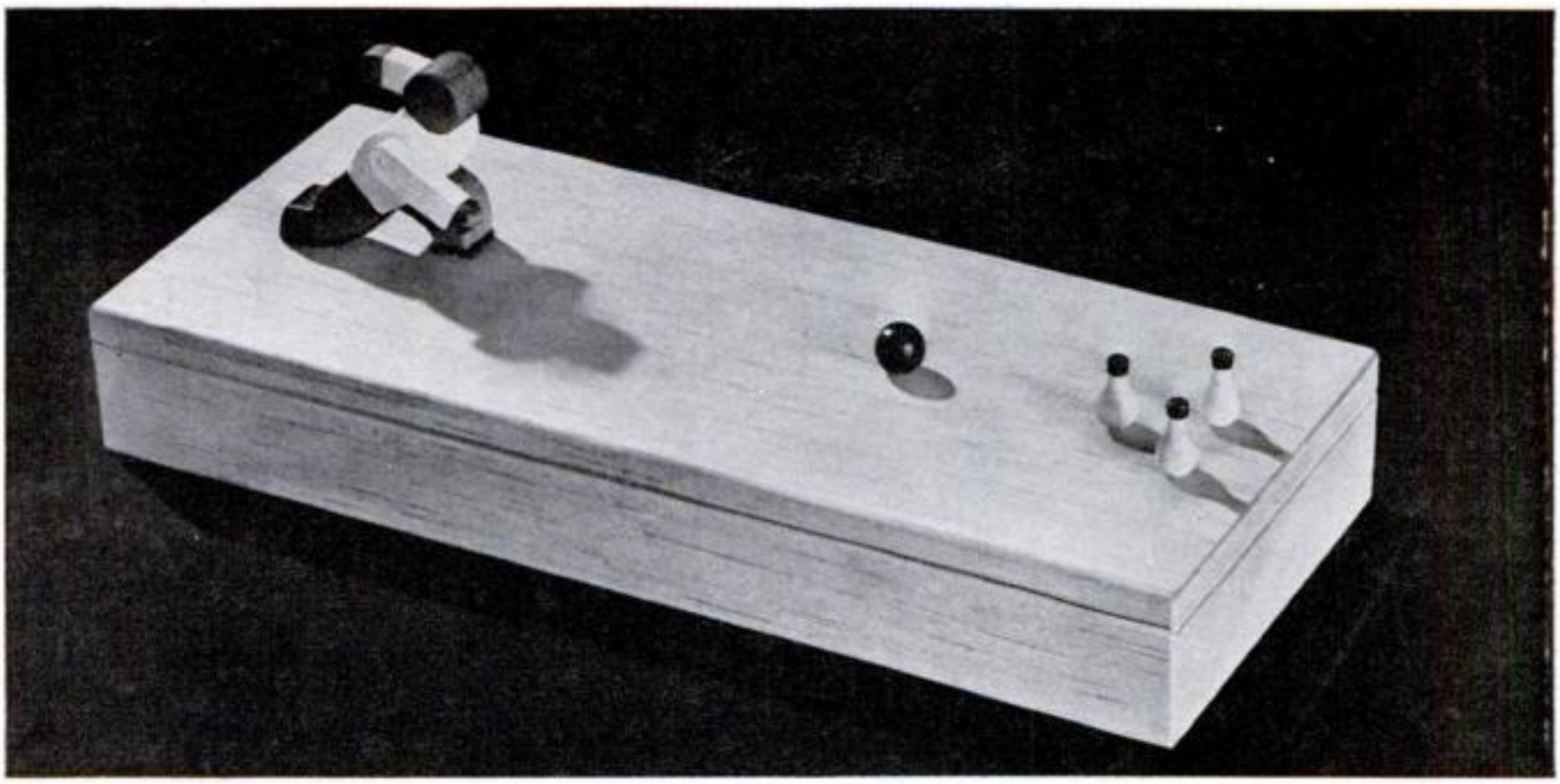
Draw the pattern on the right side of 14-ply showcard board, following the dimensions shown in the drawing; then cut with a knife and a brass-edged ruler. Where the board is to be folded, it is cut halfway through. The three rectangular openings are drawn on the reverse side of the front and cut out.

Next, the cardboard track down which the coins roll is cut out and glued, and the upper track for the glass slide likewise attached. The case is then folded, the left side glued in place, the glass slide inserted, and the lower track for the slide set in. The right side of the case is then glued in place.

Cut out the three boxlike compartments for the coins and attach them with split paper fasteners, propping them against cardboard stops at the bottom. Use gummed tape to finish the edges.—FRANK SHORE.



HW 142

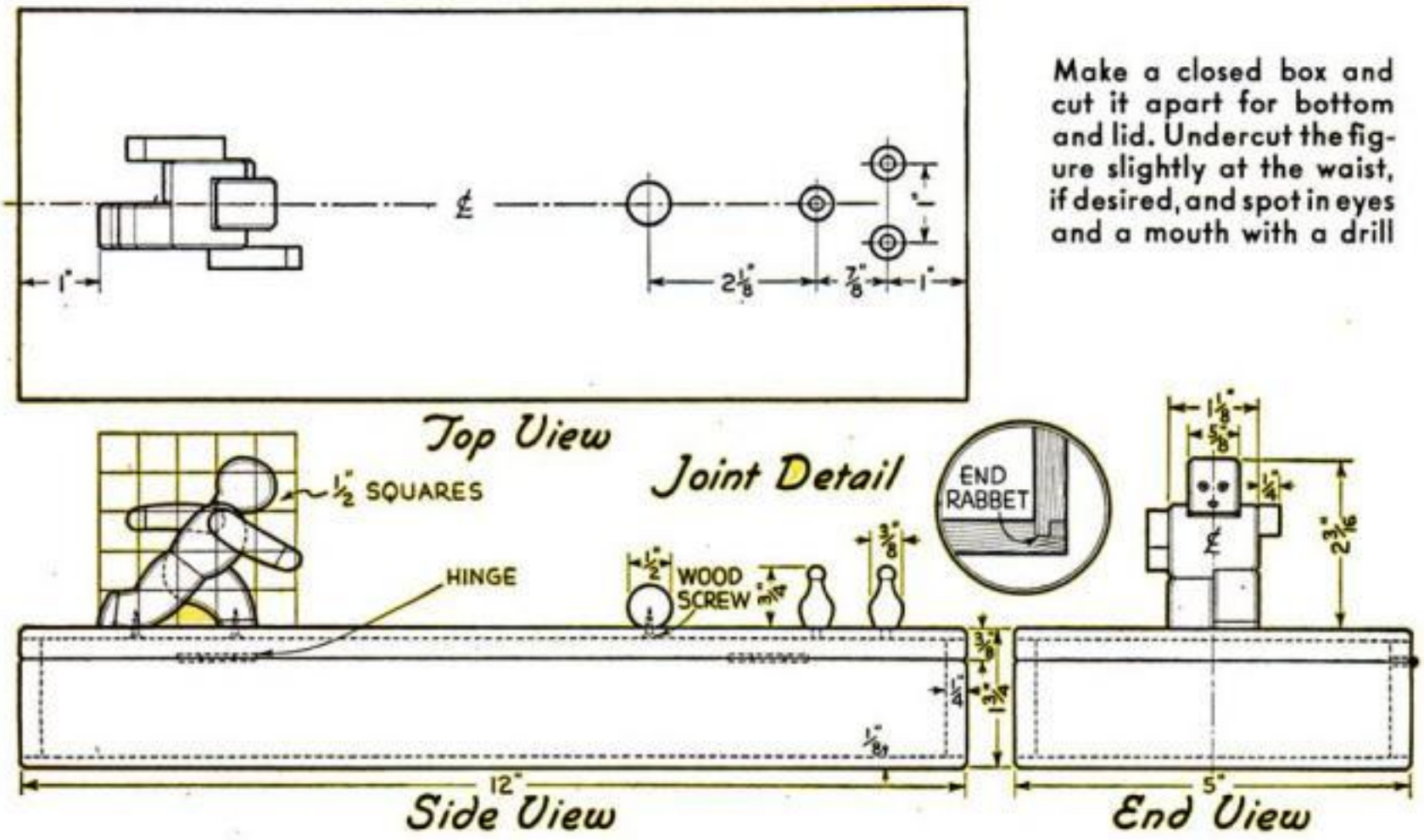


Bowling Motif Decorates Handkerchief Box for Man's Dresser

DESIGNED to hold handkerchiefs or collar buttons, cuff links, lodge insignia, and other small items, this unusual box will "strike" a sporting note atop a man's dresser. Make the box with butt joints or rabbet-and-dado joints. If it is built as a unit with the top and bottom glued in place, and then cut apart on a circular saw or band saw, lid and bottom will match perfectly. Bevel all edges and attach the lid with small hinges.

Draw the profile of the figure on a block 1⅛" by 2¼" by 2¼". Saw it to the outline; then cut back on both sides of the head to form the shoulders and cut to the halfway mark from opposite sides in front and back to form the two legs. Make the arms separately, attaching them with glue and brads. Hands, legs, and head may be stained brown, the feet black, and the upper portion of the body may be painted white.

Turn or carve the ball and three pins with a small projection on each for gluing into holes. Trim the ends flush with the inside surface of the lid. Accent the pins with black at the top and stain the ball black. A plain shellac and wax finish on the box will simulate the appearance of a real bowling alley.—JUAN OLIVER.



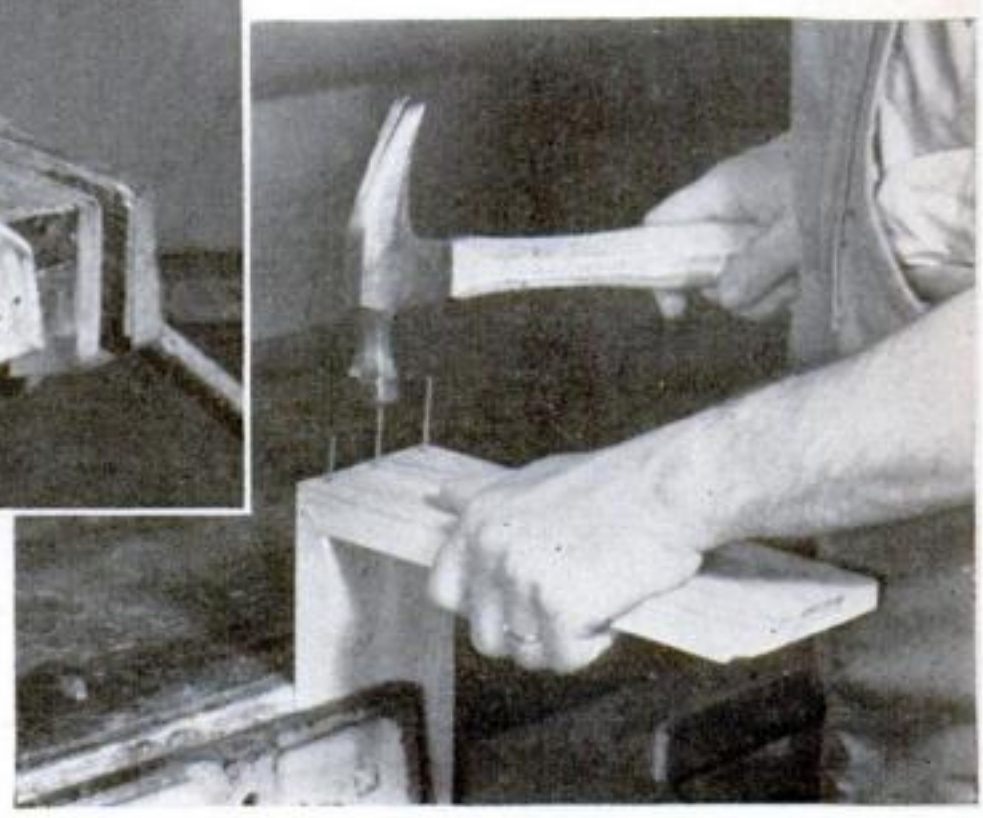
HW 143

Butt Joints and Their Uses

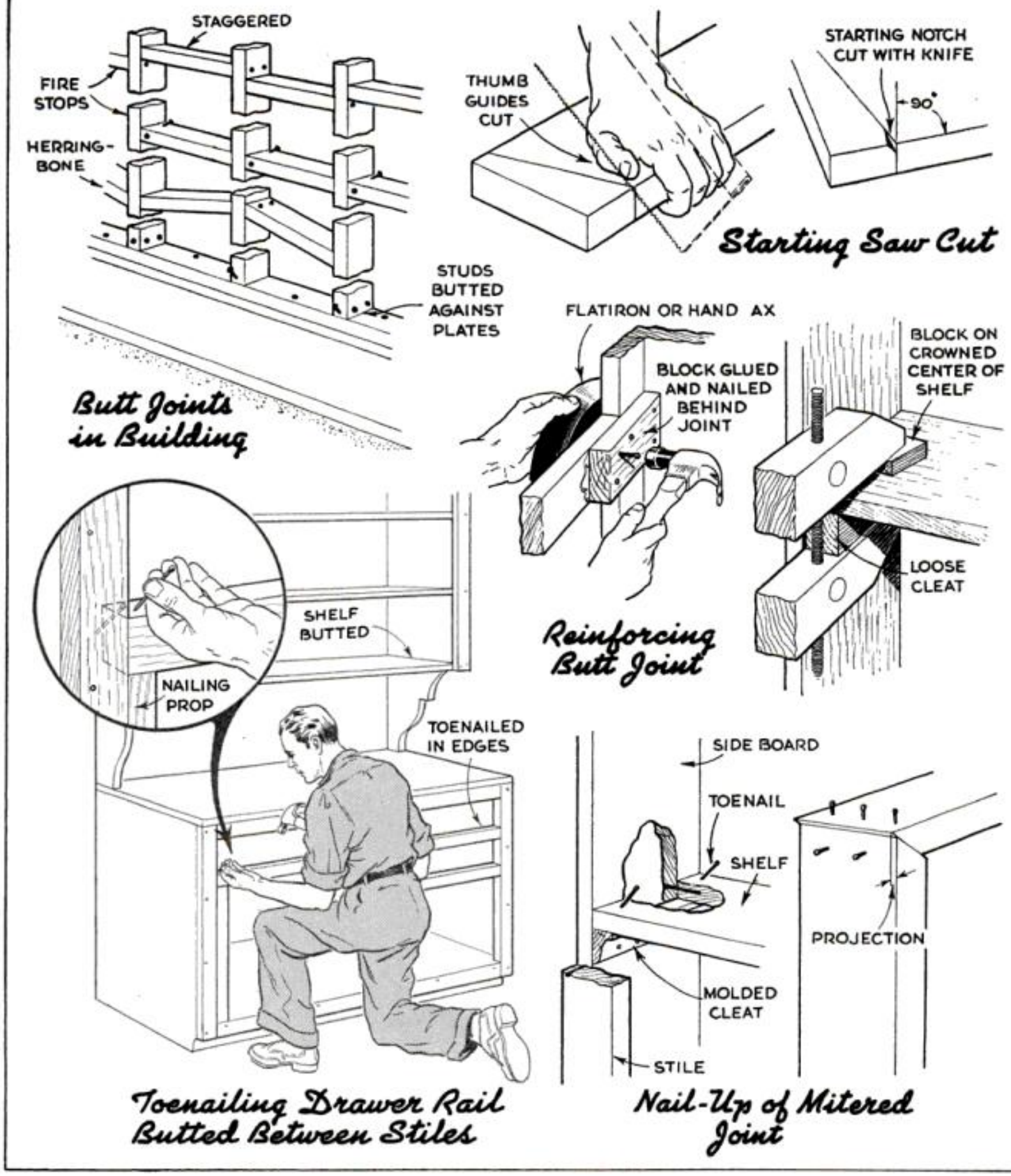
By
EDWIN M. LOVE

A BUTT joint is formed when the end of a board is fastened to the side of another. The simplest and most easily made of all joints, it is probably more often used than any other. Carpenters, when framing a house, butt studs against plates and fire stops against studs. They nail shelves to cupboard sides, toenail drawer rails to the stiles, and butt baseboards against door casings. Wooden novelties and inexpensive furniture are often assembled by means of butt joints.

For such uses this joint is satisfactory. Its natural weakness is balanced by ample nailing and bracing in houses. In fact, butt joints are used throughout the framing of a house. In addition to studs, plates and fire stops, all diagonal bracing at corners is made with butt joints. Floor joists and the bridging that holds them rigid also rely upon this joint for stiffness. Walls offer a firm support to built-in cabinets constructed with butt joints. Novelties are usually rein-



To nail a square butt joint, as above, start the nails in one piece. Then, adjusting the joint with a forefinger, drive a single corner nail in first. A mitered joint, as shown at the right, is nailed with the top piece protruding slightly. It will draw into alignment as the nails are driven home



forced with glue. The home mechanic can make good use of butt joints in constructing fences, pergolas, garden furniture, and many pieces of household equipment.

As with all joints, the value of a butt joint depends much on the laying out and cutting of it. When new, mill-surfaced lumber is used, it can reasonably be assumed that the edges are parallel and square. If the end of the board is to be sawed, scribe a line across the face and edges, using a sharp, hard pencil, or better still, the point of a knife. However, a board that needs cutting to size should be prepared with special care. First, plane one side and mark it for a working face. Next, joint one edge, checking it with a try square or bevel square. Guide against this edge to gauge the piece to width. Finally, gauge the board for thickness and plane the other side.

When starting the saw cut, extend the thumb to act as a guide, or notch the corner of the piece with a knife. Run the blade of the saw in the waste wood with the teeth splitting the line. The man who has trouble making a true vertical cut will find a guide

block held against the blade to be helpful.

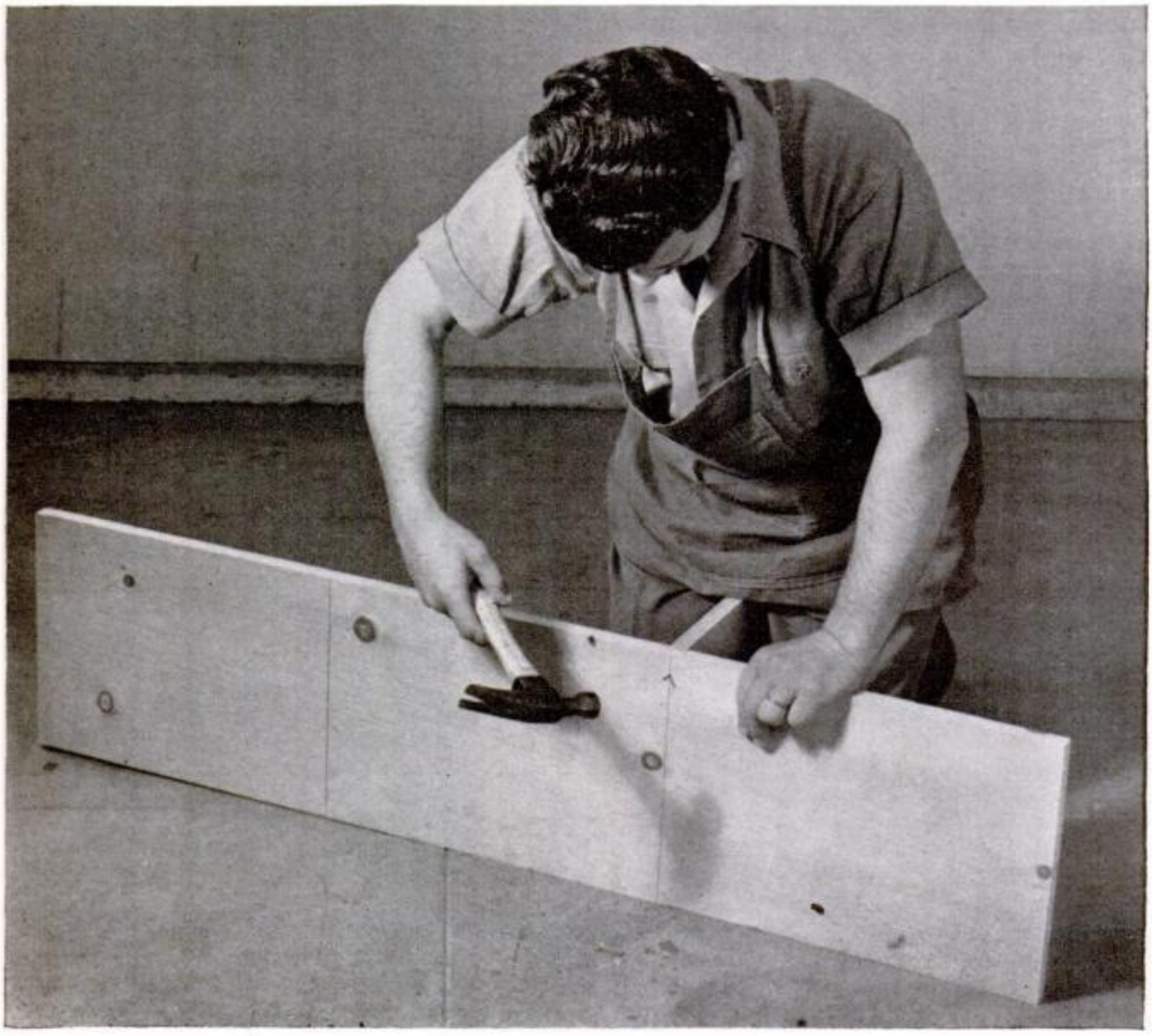
When one piece of material can be held in a vise, it is easy to nail a narrow butt joint. Start the nails in the other piece as it lies on the bench; then nail it as shown in one of the photographs, using the forefinger of the left hand to adjust the joint while the first nail is driven part way. Thereafter the upper piece can be pivoted on the first nail to the exact position for driving the second nail. Use a variation of this method to nail wide boards together, springing slightly warped lumber straight by prying against nails already driven. In such cases extra nails may be needed. Wide boards too large to hold in the bench vise can be held between the legs for nailing.

A clamp and a loose cleat can be used to flatten a warped shelf before nailing. Many kitchen cupboards are built with plain butted shelves, but strength can be added by nailing cleats to the side boards under the ends of shelves. If a simple molding is used as a cleat, it will not detract from the appearance of the cupboard. Should a shelf be cupped upward, it can be flattened by toenailing from above.

The shrinkage of wood across the grain must be considered in making butt joints. Wherever possible, join width to width, so that both members will shrink and swell alike. Avoid joining different species of woods having unequal shrinkage characteristics, for nails may work loose and cause failure of the joint. Should the nails succeed in holding the edges firmly despite uneven shrinkage, checks will probably appear.

Similar to a butt joint is that in which a board is lapped over the edge of another board, as when a cabinet stile is nailed to the front edge of a side board. In joints such as these glue holds well, and in all but the cheapest furniture construction will repay the slight time and labor involved in applying it. However, glue usually fails when used on end grain.

When nailing butt joints too large to put into a vise, the work can be held securely between the legs in a kneeling position, as below. Nail one end of the joint; then reverse the work to nail the other end

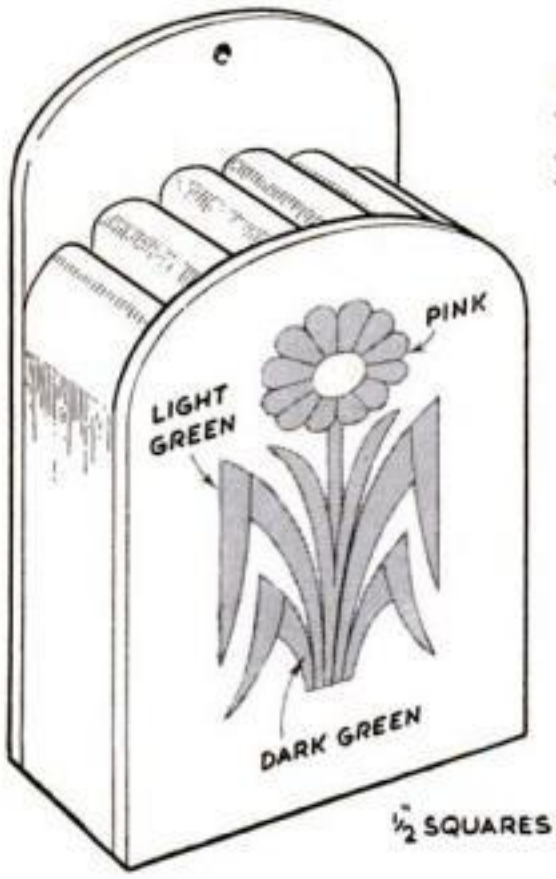


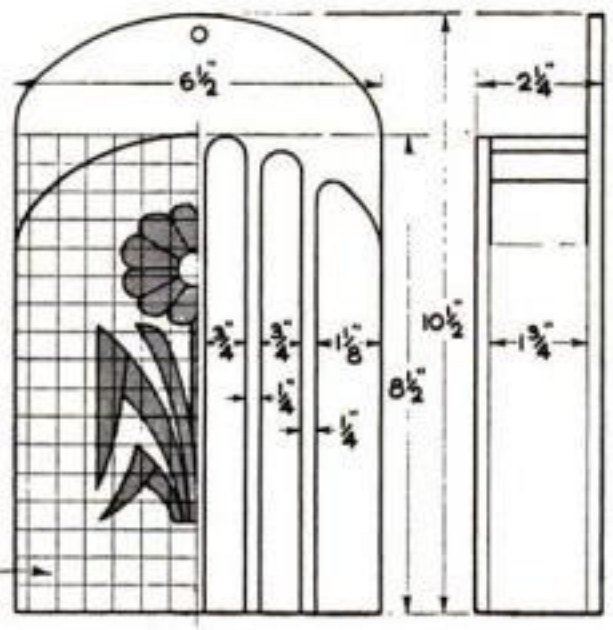
A square block of wood held against the saw will aid in making a true vertical cut, which is important in the correct fitting of butt joints

A simple miter joint, as shown in one of the photographs, is little more than a butt joint but has the advantage that it conceals the end grain. It is useful for applying trim such as a wainscot cap around a pilaster. Since the piece in which the nails are being driven generally slides down the slope of the joint, it should be allowed to overlap the other at first. Do not drive the nails home immediately, but wait until the joint is partly nailed from the other direction. Any inequality can then be adjusted by tapping nails alternately on one side and the other.

In places where miter joints are used and one or more pieces can be nailed in place before abutting pieces are put on, it is usually best to sand joints to a perfect fit before nailing the abutting pieces in place. Such places occur when fitting moldings or baseboards at both outside and inside corners of a cabinet or applying inside trim.

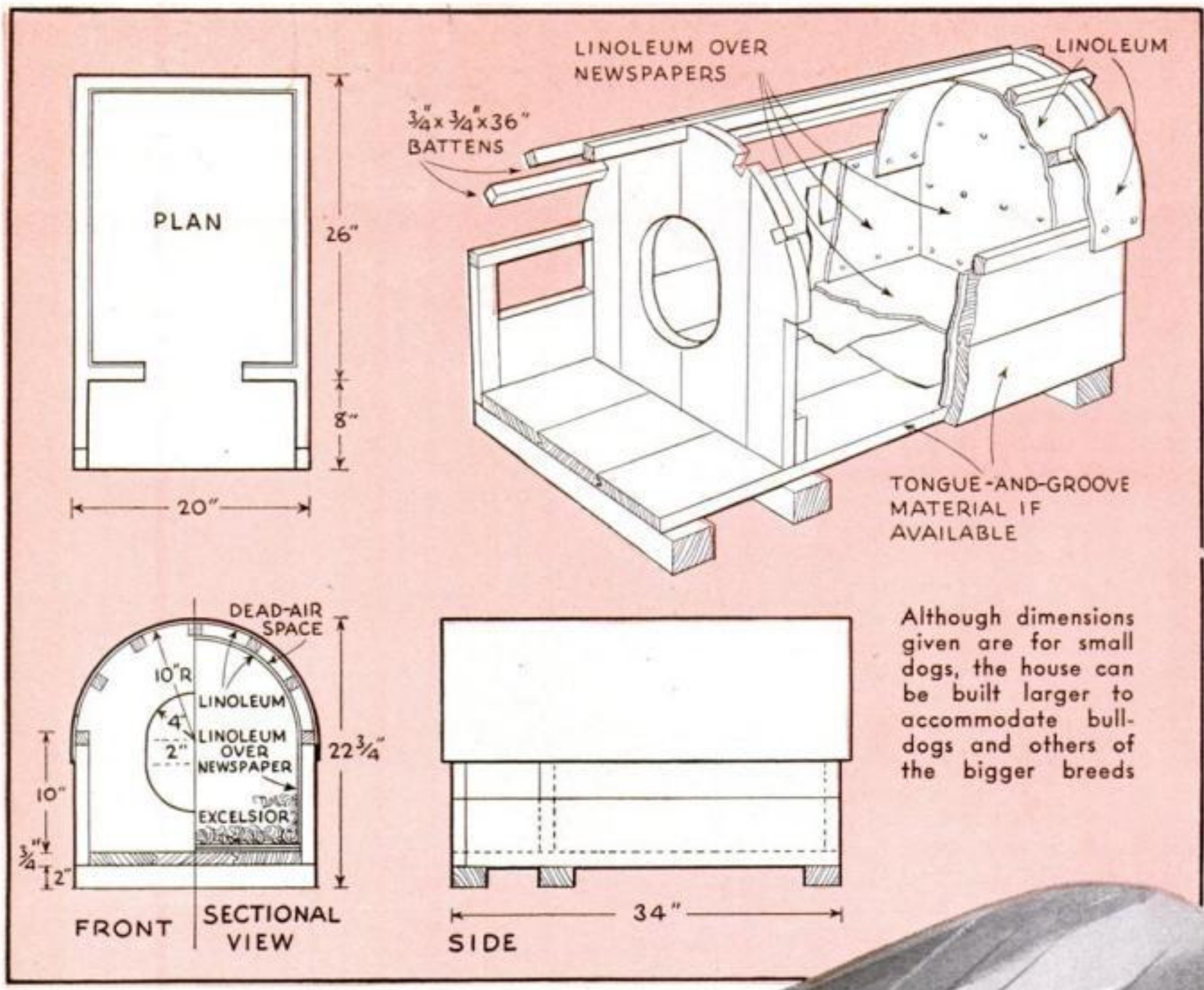
Kitchen Knife Rack Is Made Entirely with Butt Joints





THIS kitchen rack for bread and carving knives is assembled with butt joints. Trace a half pattern for the front piece and decoration by following the lines on ½" squares. Saw out the front and back and smooth them carefully. Prepare the partitions by accurately squaring the edges and rounding the upper ends. Lay the partitions in place on the front piece, separating them with strips of ¼" plywood; then mark and cut the bottom ends. Clamp the pieces together again in position and nail through the back. Remove the plywood separating strips and nail the partitions through the front. If figured hardwood is used for a stain and varnish finish, glue the front on instead. Weight or clamp it until the glue is dry.—E. M. L.

HW 147



Although dimensions given are for small dogs, the house can be built larger to accommodate bulldogs and others of the bigger breeds

INSULATED

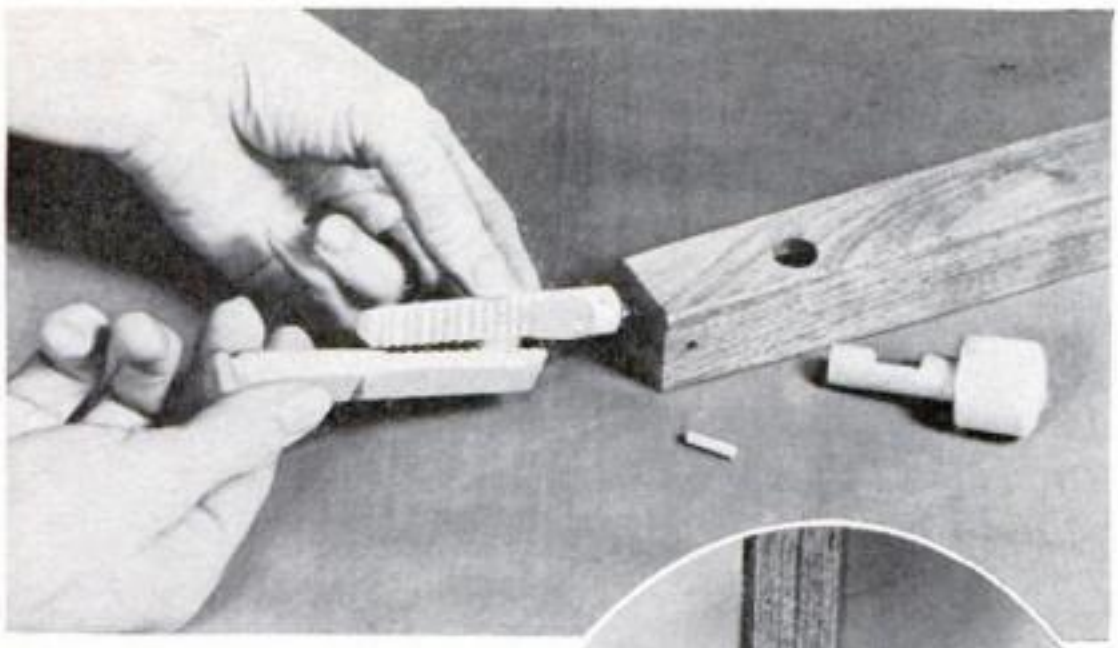
DOG HOUSE

LINOLEUM remnants and odd lengths of lumber are all the materials needed for this insulated dog house. The dimensions given are suitable for small dogs but can be increased to suit.

A floor of tongue-and-groove boards is laid on three 2 by 3's, and the sides and ends are erected upon this. The ends are cleated on the inside and notched for the roof battens as shown in the drawing. Walls, floors, and ends are well insulated with linoleum placed over several layers of dry newspapers. Be sure to warm the linoleum before bending it so that it will not crack. That on the roof is put on last and should come down a few inches over the side so as to give adequate protection in stormy weather. Place the smooth side uppermost and give it two coats of outdoor paint. Bed the floor of the house with excelsior.

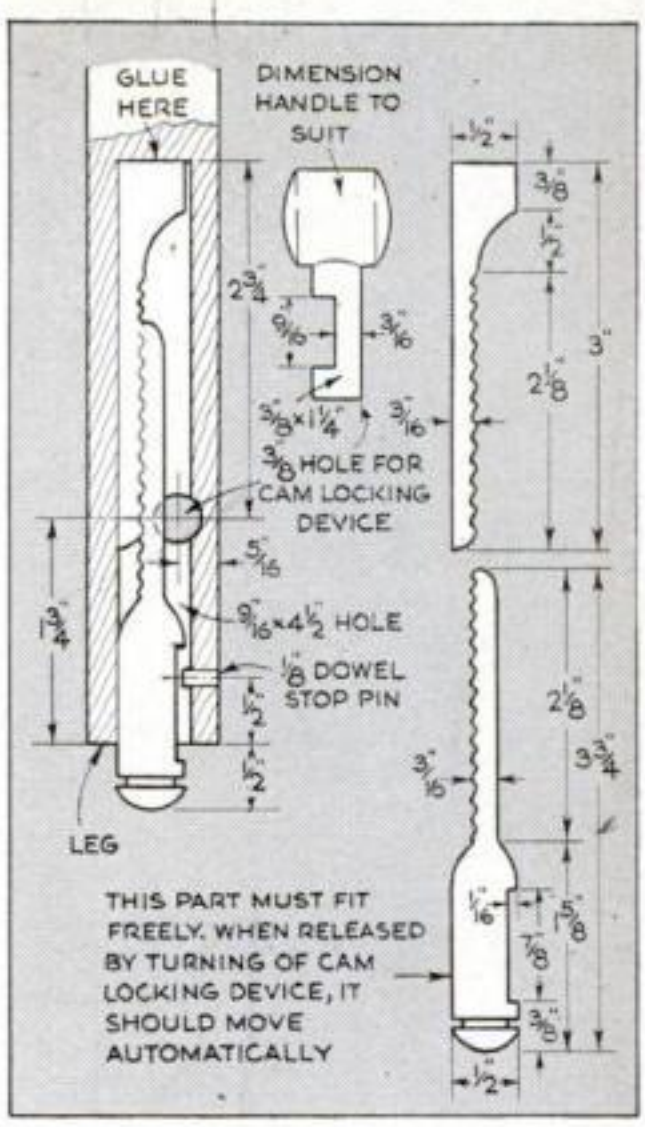
The open doorway provides ample ventilation, while the front "porch" serves as a platform for water and food dishes, and keeps driving rain out.

"Peg Leg" Device Steadies Card Table on Uneven Surfaces



Above are shown the four pieces that comprise this card-table adjusting device

A simple cam controls the operation of one movable piece up or down against a corrugated stationary piece firmly glued inside



A UNIQUE, easily made device eliminates the annoying wobble resulting when a card table is set on an uneven floor. Built into one leg, this extension permits the length of that one to be changed so that all four legs of the table will rest firmly.

Saw ½" off the bottom of the leg and bore a 9/16" hole up through the center to a depth of 4½". Intersect this hole with a ⅜" hole bored horizontally through the leg at a point 1¾" from the bottom and, for a leg that is 1" square, 5/16" away from one edge. Drill a ⅛" hole in the side of the leg, and also at a right angle to the vertical hole, ½" from the bottom. Shape the two dowel pieces as shown and glue the stationary piece all the way up into the hole, with its notched face parallel to the ⅜" hole.

Make the cam pin and insert it in the side hole, turning it so that the movable dowel can be adjusted to protrude ½" from the end of the leg; then lock it in place. The stop pin is then glued into its hole with sufficient clearance to allow for easy adjustment of the lower dowel.

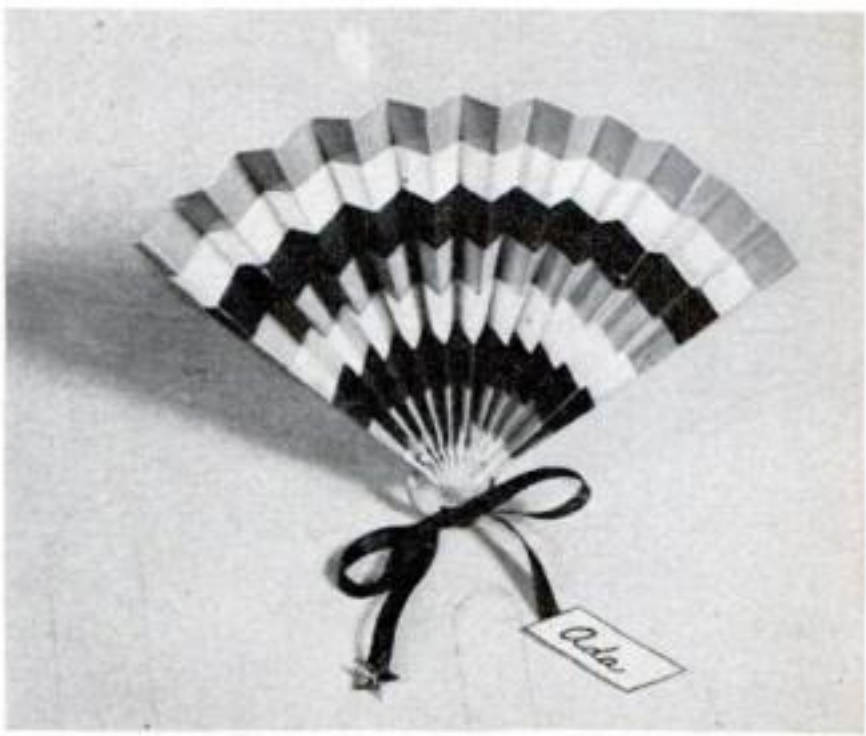
In operation, the movable dowel may be lowered or raised, depending on whether the table leg is to be shortened or made longer. A twist of the cam loosens the grip of the grooves, the card table is leveled, and the cam is turned once more to secure the setting.—BENJAMIN NIELSEN.

Party Favors Resemble Fans

GAY fan place cards that will add a sparkling touch to any dinner table can be made inexpensively in a few minutes.

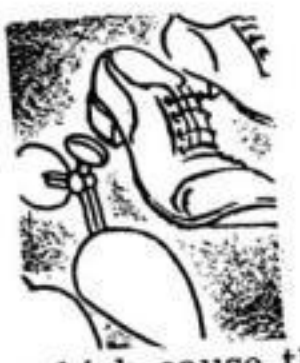
Choose any color paper desired and fold it back and forth, accordion-pleat fashion. Holes are punched at one end of the pleats, and into these holes a poultry marker is slipped. The marker is spread wide enough to stand upright. Add a bright ribbon, as shown in the photo, paste a star or some other decoration to one end of the streamer, and stick the name card to the other.

The colors chosen for the favor pictured were red, white, and blue—an appropriate patriotic motif.



More Mileage from Shoe Leather

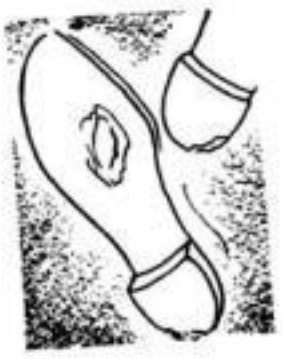
THREE pairs of shoes should be ample for the average person. Government officials have been backed up in this opinion by leading shoe-repair men, who say that a pair of good shoes properly taken care of should last not only four months, six months, or a year, but literally for years. But you can't be slipshod and be well shod! Here are several points that should be observed to make shoes give longer service and retain their looks at the same time.



SHOE TREES are as important to your shoes as hangers are to your clothes. Feel along the inside lining of your shoes. Do you notice any bumps, curves, sags? These come as a result of dampness, moisture, and perspiration, which cause the inner soles and linings of footwear to curl up or warp out of shape. If you place trees in your shoes promptly after taking them off, the shoes will be molded back into shape.

SHOEHORNS are another accessory too often neglected. The backs of your shoes are tender and have the least support of any part of the shoe structure. They will break down completely if you push your feet into them without the aid of a shoehorn. It is almost impossible to repair shoes with broken backs, but it is easy to avoid this.

THOROUGH CLEANING and polishing is a vital part of shoe care. Saddle soap or any other good leather soap should be used frequently in order to remove dirt from your shoes. Never polish *over* the dirt. After cleaning, give your shoes a high polish, for this keeps the leather soft and flexible. It is always advisable to use leather soap and polish after shoes have been exposed to wet weather.



THIN SOLES are a warning to have shoes resoled promptly. Don't wait until a hole appears. Shoes are much harder to repair satisfactorily when holes are present, especially men's shoes, in which the inner soles become damaged. The same advice applies to the heels of your shoes. Badly worn heels throw the feet out of position, strain the shoes, and cause uneven wear.

CORRECT SIZE is important. Be sure the shoes you purchase are large enough, for too-small shoes will soon be pushed completely out of shape and will wear much faster. Have your size checked frequently. Your feet may continue to grow even through middle age. A poor fit will harm your feet as well as the shoes. When you buy shoes, try on both of the pair.

HEAT dries out the leather, causing it to crack, split, and otherwise deteriorate. Therefore, keep your shoes away from radiators, fireplaces, and the like. Dry wet shoes in a cool place.

DON'T wear the same pair of shoes continually. Your shoes will last much longer if you change them often. Frequent vacations on shoe trees reshape and rehabilitate them.

RED AND WHITE

BROWN BLENDING INTO FAWN BELOW

WHITE, YELLOW BILL AND LEGS

WIRE

YELLOW

PINK

RED ON WHITE

RED

DO NOT PICK THE FLOWERS

SASH CORD

TAN

¼" DOWEL PAINTED WHITE

BLUE

BROWN

PUT EARTH MOUNDS EACH SIDE OF SHRUB

DARK BROWN

BLACK

DARK GREEN ON LIGHT

BLUE PANTS

YELLOW

WHITE

BLUE

BRIGHT-COLORED PRODUCE

Liven up your lawn with the figures shown in the drawing. They are scroll-sawed from ⅜" outdoor plywood, or else from ¾" solid lumber joined edge to edge with waterproof resin glue and doweled at all weak points

Designed by HI SIBLEY

THIS END PLUGGED

ADHESIVE TAPE

DELPHINIUM

NAME ON PAPER INSERT

CELLULOID OVER BLOCK ½" × ¾" × 3"

ALL 2" SQUARES

LIGHT YELLOW

BROWN

BRIGHT REDS AND BLUES

TAN

BROWN

BLACK

HARDWOOD STAKES ON LARGE FIGURES

(LAMB)

IRON ON SMALL ONES

ODD PIECES OF ¾" MATERIAL GLUED TOGETHER AND FIGURE DOWELED WHERE MOST LIKELY TO SPLIT

WHITE WITH BROWNISH-GRAY LEGS AND FACES

YELLOW

(SHOULD HAVE A BRACE IN BACK)

BLACK

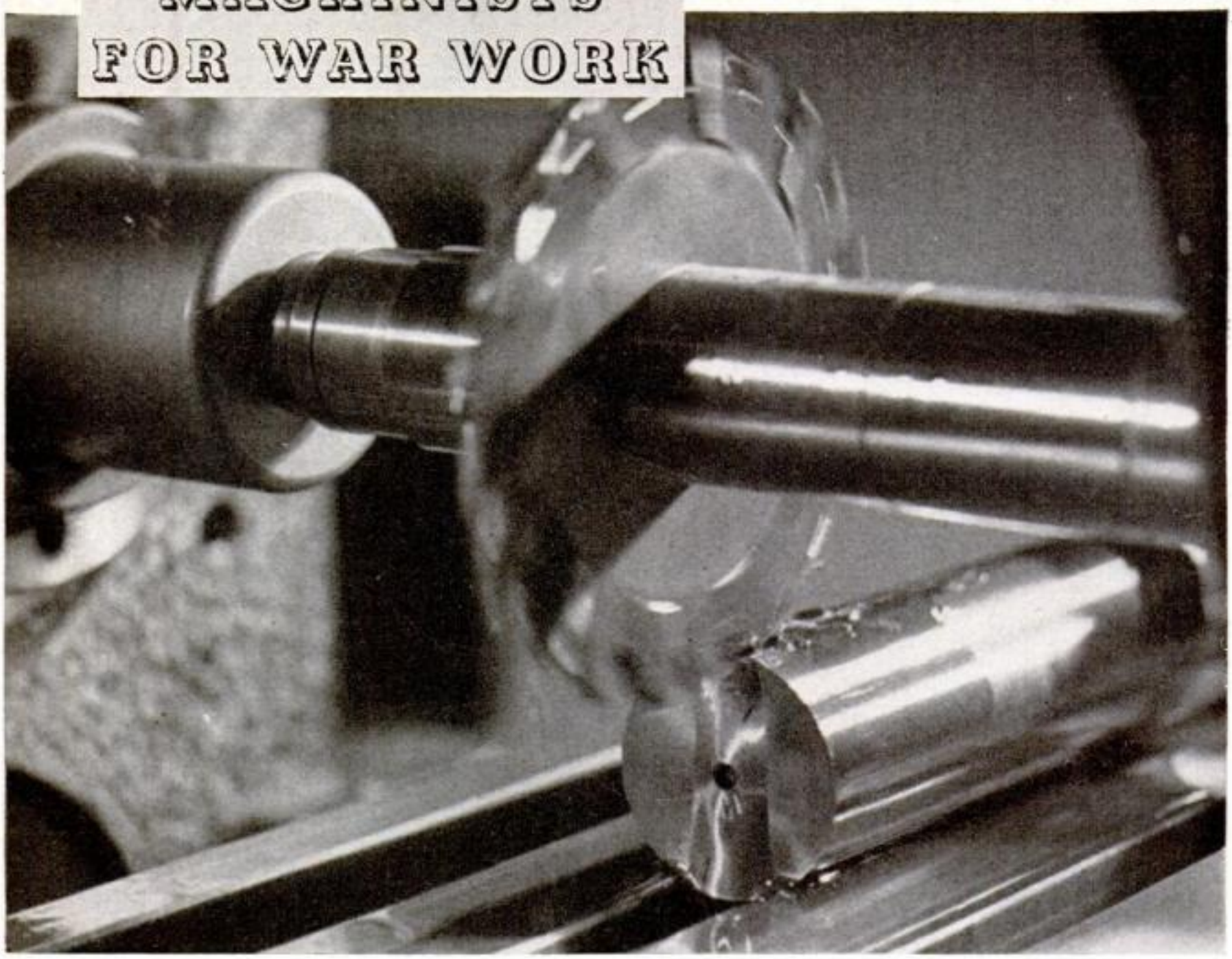
BLUE

RED

GREEN

BROWN

MACHINISTS FOR WAR WORK



MILLING KEYWAYS

TO ASSIST in the tremendous task of training unprecedented numbers of wartime workers, the United States Office of Education has prepared a series of 16-mm. sound films that show, in considerable detail, the operation of various machine tools used in industry. These motion pictures, distributed for the Government by Castle Films, are of great value to those preparing for machine-shop work because they clearly depict the steps involved in performing typical jobs. Don't fail to see them when they are being shown in your community or at your plant.

WHEREVER you find machinery, you are likely to see gears and shafts. Wherever a gear and shaft must rotate as one, they are locked together —often by a key fitted snugly into matching keyways. The accurate cutting of these keyways is one of the many important operations performed by the modern milling machine in producing the parts for America's heavy war weapons. Accompanying photographs show step by step how a typical keyway is milled.

The job starts with a blueprint calling for a keyway 3/16″ deep by 5/16″ wide by 3″ long in each end of a 2″ shaft 18″ long. First of all the operator checks the shaft dimensions to make sure he has the right piece for the job.

When ready to set up the work, he brushes off the milling-machine table and wipes clean all parts that are fitted or clamped together so that they will line up accurately. Then he lubricates the operating mechanism and, in the slot on the table nearest the headstock, secures the

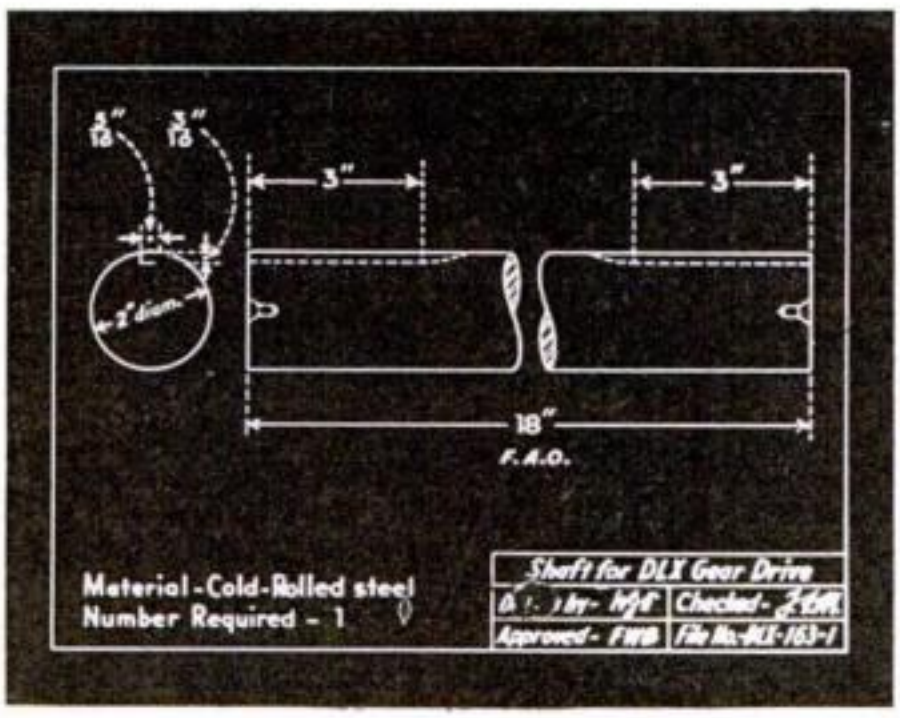
shaft to be machined rigidly in place with two U-clamps and heel blocks. The arbor is inserted in the spindle and a draw-in bar is screwed in from the rear to set it solidly in position. Care is taken to see that both the spindle and arbor tapers are clean.

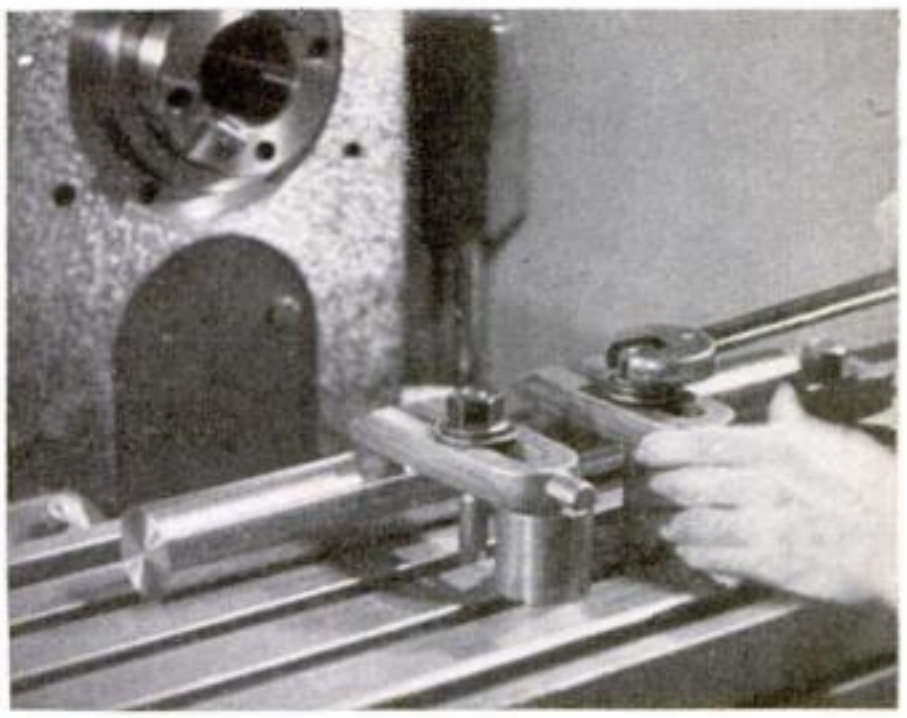
The machinist next selects a suitable slotting cutter with teeth 5/16″ wide—the width of the keyway—and places it on the arbor with the necessary collars. He slides out the overarm bracket to support the arbor, being careful to locate it far enough out to clear the table clamps when the shaft is run in for cutting.

How shall the operator center the shaft under the cutter? Using either the power-driven or hand controls, he raises the shaft alongside the cutter, leaving a space of .015″ between shaft and teeth, as determined by means of a .015″ feeler gauge. In this position, the distance from the center of the cutter to the center of the shaft is equal to .15625″ (half the width of the cutter) *plus* .015″ (the thickness of the feeler) *plus* 1″ (the radius of the shaft). This totals 1.17125″ and represents the distance the table must be moved in toward the headstock in order to center the shaft precisely under the cutter.

To make this adjustment, the machinist lowers the table and sets the index dial on the cross-feed screw at zero. Since the dial is divided into 250 calibrations, each of which represent a table movement of .001″, a full turn advances the table .250″ or ¼″, and four complete turns plus .171″ will bring the shaft to the desired location.

With the table locked in this position, the operator is ready to calculate the cutting speed. Three factors enter into his selection: (1) the nature of the material to be cut, (2) the material from which the cutter is

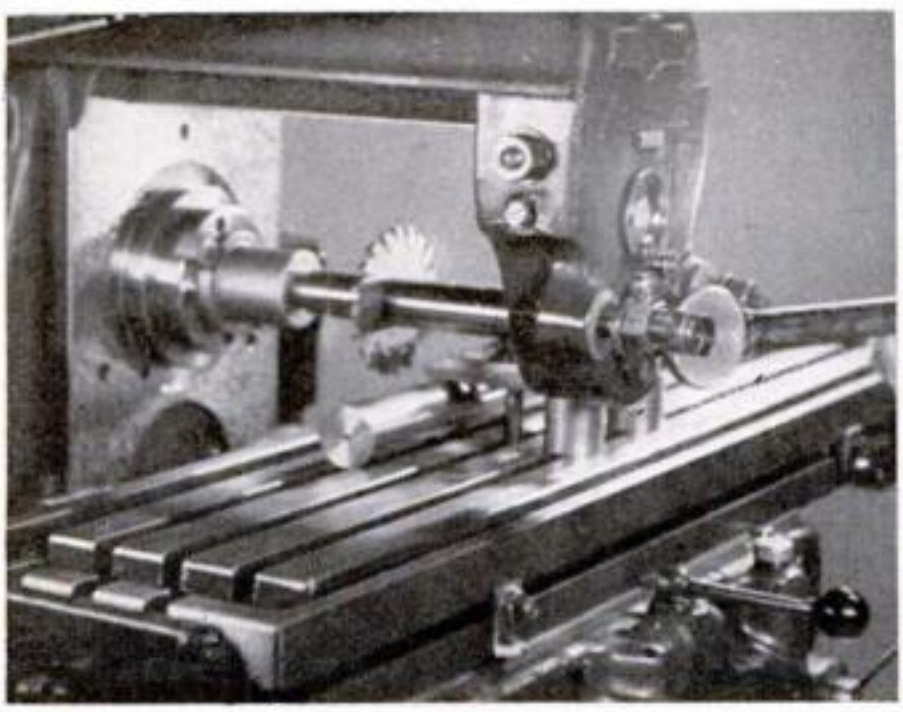




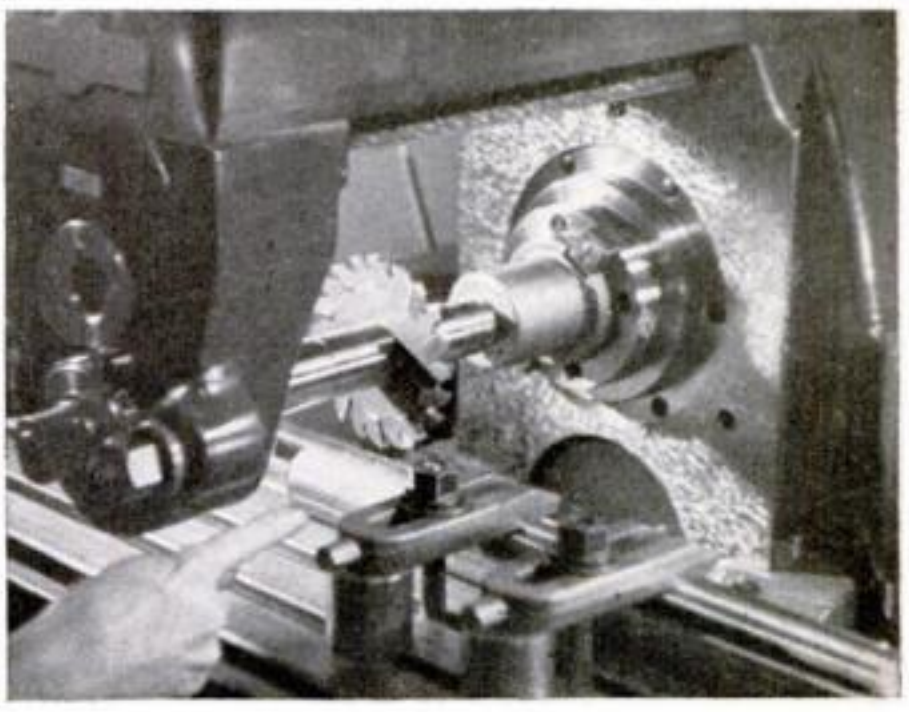
1 All jobs start with blueprints giving required dimensions. Note that each keyway is measured only to where the cut begins to leave the shaft

2 Brush the milling-machine table clean, and then clamp the shaft to it in the slot nearest the headstock, using two U-clamps and heel blocks

3 Next the arbor shaft is set into the spindle, the cutter is adjusted with collars, and the overarm bracket is slid out to support the arbor



4 Since the work is near the headstock, a short arbor shaft is used. The overarm bracket must be located to clear the clamps during the cutting

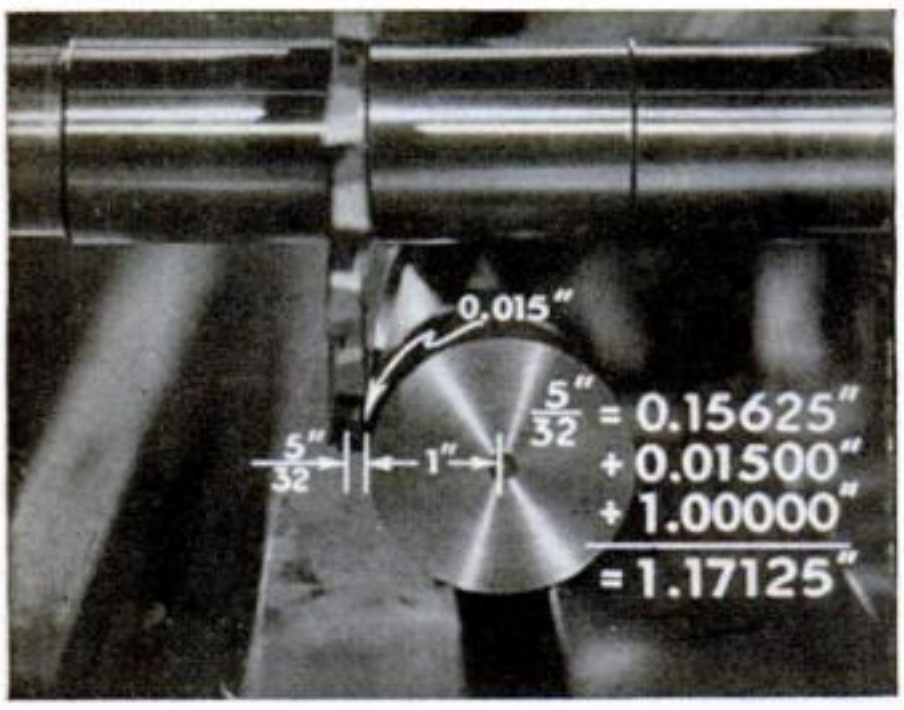


made, and (3) the diameter of the cutter. In this instance he is cutting cold-rolled steel with a 5" cutter made of high-speed steel, and according to the reference chart 100 surface feet per minute at the cutter teeth is a recommended speed.

The machinist now makes some rapid calculations. "Since the cutter is 5" in diameter," he reasons, "its circumference will be five times *pi*—that's 15.708" or 1.309'. The speed in feet per minute at the cutting teeth is to be 100. Dividing this speed by the circumference in feet gives me 76—the number of revolutions per minute I need. This setting does not appear on the spindle-speed dial, so I'll simply choose the nearest available setting, which is 74."

Having centered the shaft and established the cutter speed, the operator must now find the correct feed, or the number of inches per minute at which the work is brought into the cutter. For a 3/16" cut (the depth of the keyway) each tooth should remove a chip about .002" thick. This chip thickness, times the number of teeth on the cutter—20 in this case—equals .040", or the distance the work is fed into the cutter in one complete revolution of the latter. To find the feed per minute, he merely multiplies .040" by the cutter speed, 74 r.p.m., which gives him a feed of 2.960" per minute. The nearest setting to this on the feed-speed dial is 2¾", so he sets it accordingly.

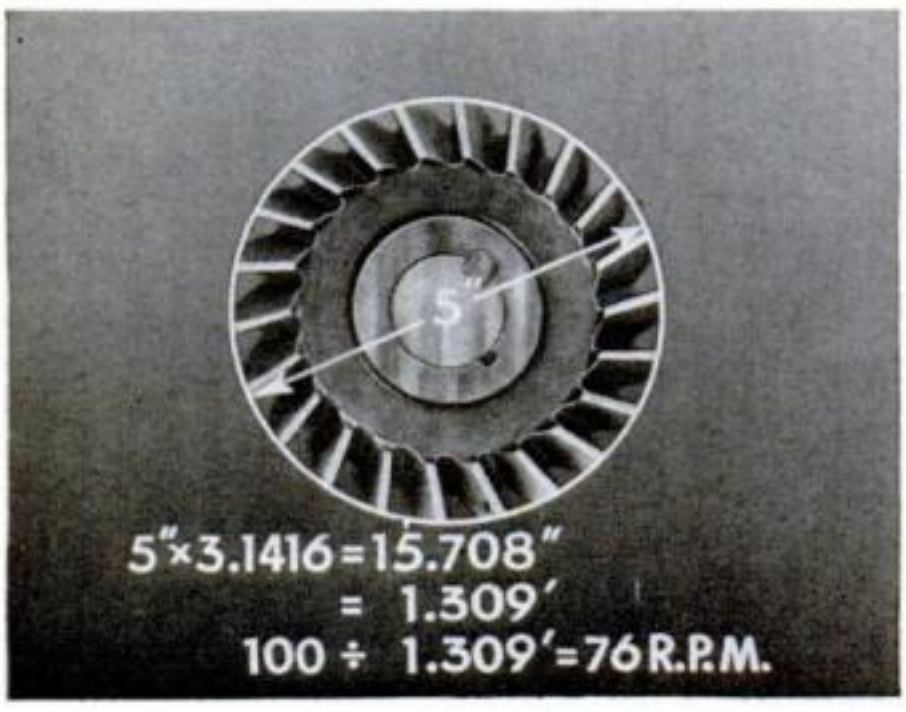
The milling machine is now ready for a short trial run, at the end of which the table is brought up by hand until the cutter just misses the shaft. The machine is then stopped, and the vertical feed index is set at zero. Now, the operator traverses the table manually until the cutter rests 3" from the end of the shaft, the specified length of the keyway. He locates the table stop to halt the table automatically when it reaches this position; then he runs the table



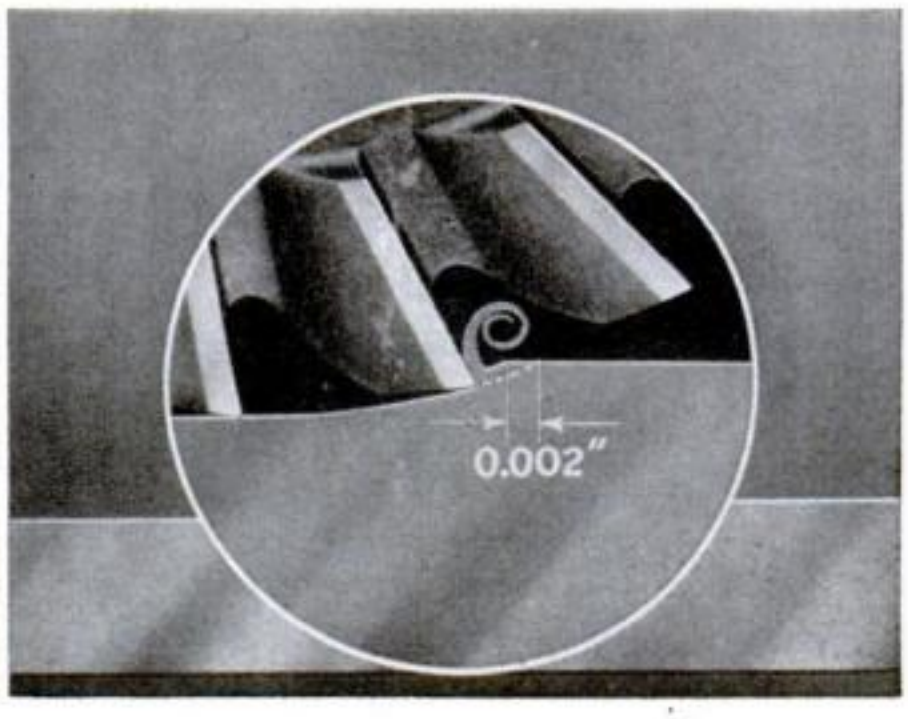
5 To center the work, bring it alongside the cutter with a .015" feeler gauge between. Add up half the cutter width, .015", and the shaft radius

6 Lower the table, set the cross-feed index at zero, and move the table over four full turns of the collar (which will equal 1") plus .171" more

7 Cutter surface speed of 100' per minute is taken from the reference chart and reduced to r.p.m. by multiplying the diameter by *pi* (3.1416)



8 Feed, or the rate at which the work is fed, is next established. For a 3/16" cut, each cutter tooth will remove a chip .002" thick . . .

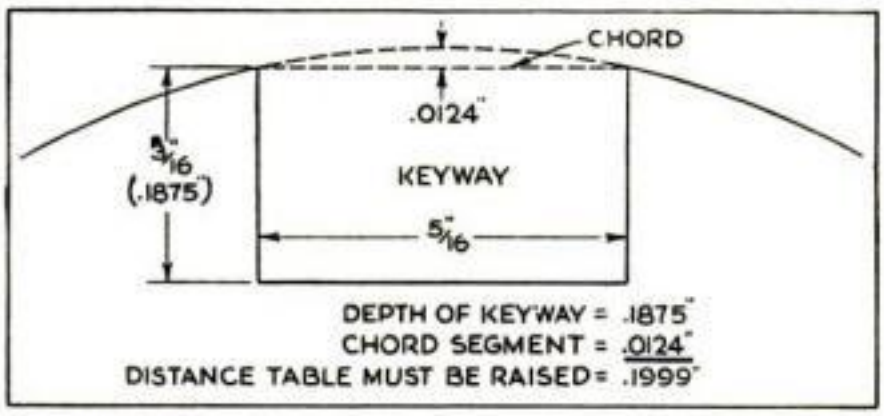


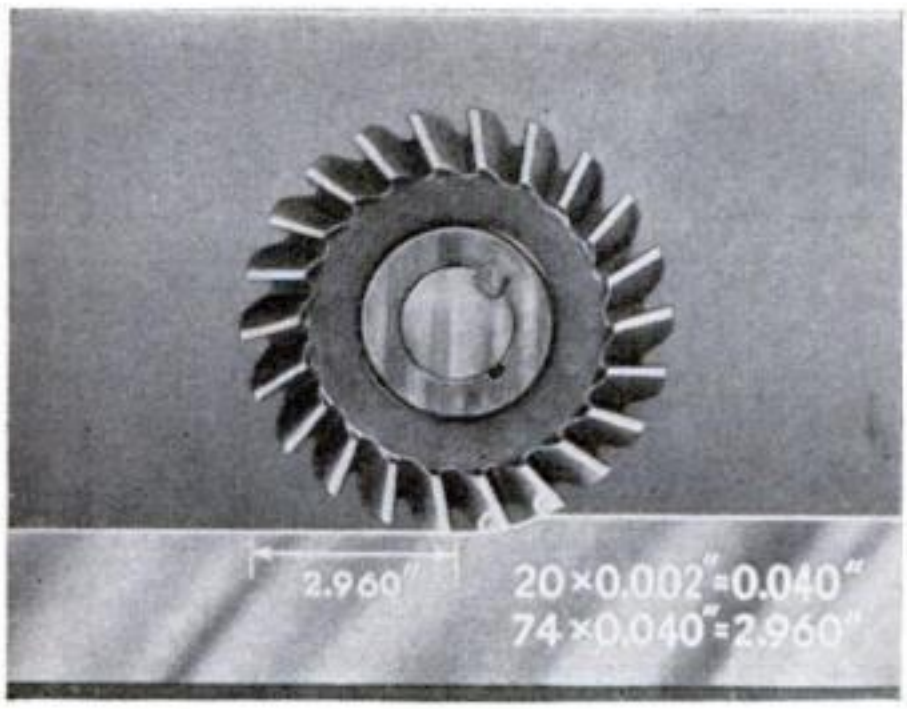
back and raises it to the height required for the cut.

The keyway is to be 3/16" deep, but milling the cylindrical shaft will produce a chord, and it is from this that the depth of the cut must be measured. Consulting a handbook, the machinist learns that the metal removed down to the chord is .0124". He raises the table, therefore, 3/16" or .1875" plus the thickness of the chord segment (.0124"), which gives him .1999" or roughly .200". Since one complete revolution of the vertical feed screw is equal to .100", two revolutions will provide the desired movement.

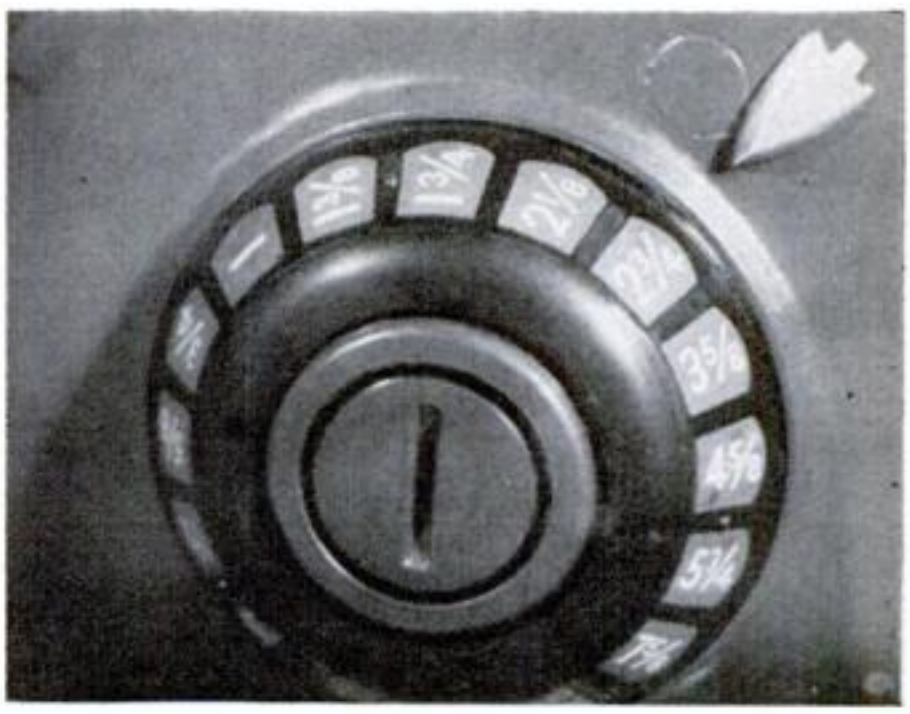
The operator locks the knee of the table in this position, starts up the milling machine, and cuts the keyway for about ¼". Stopping the machine, he runs the table back and measures the depth of the cut. This he finds is 3/16", as specified on the drawing, so he starts up the motor once more and finishes the keyway. In checking length, he measures to the end of the flat.

He now prepares to machine the other end in the same way. He lowers the table so the cutter clears the shaft and its clamps, and traverses it until the opposite side of the shaft is under the cutter. Since the cutter teeth must always travel into the work against the direction of feed, this cut is started from a point 3" along the shaft, rather than from the edge of the shaft as in the case of the first keyway. In other respects the procedure is similar.

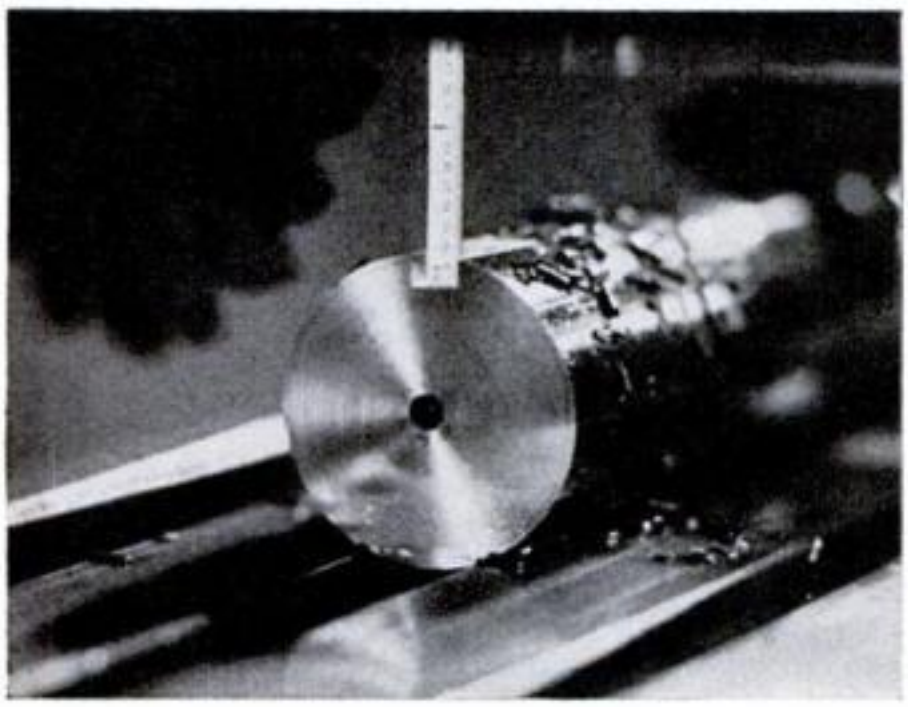




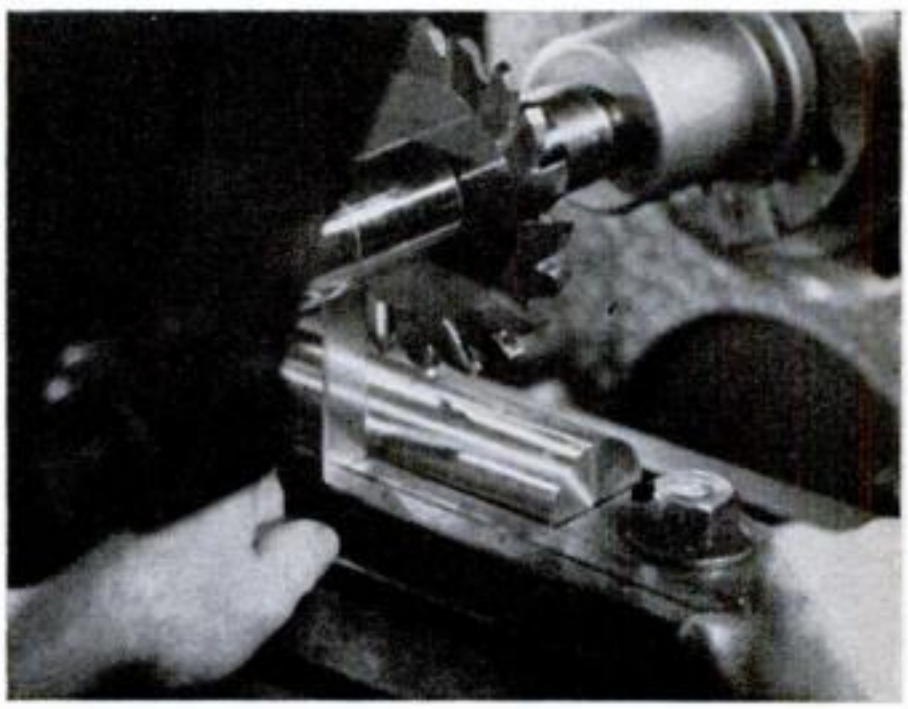
9 . . . Chip thickness times 20, the number of teeth, gives feed distance for one revolution. This is now multiplied by the r.p.m. setting . . .



10 . . . Thus, 74 r.p.m. (the nearest setting to 76 r.p.m.) times .040" equals a feed of nearly 3". The nearest setting to this is 2¾"



11 The cut must be slightly deeper than the keyway to allow for the chord segment shown in the drawing above. Check after a trial run



12 In milling the second keyway, the cut begins 3" from the end of the shaft. Steel rules are used to set the cutter at the starting point

NEW SHOP IDEAS

AN ORDINARY DENTAL MIRROR, a little chrome-backed reflector attached to a long handle, aids in inspection of the spline "teeth" in airplane-motor crankshafts at one aircraft-engine plant. The mirror can be put in corners inaccessible to direct vision for searching out minute grains of foreign metal that might damage the teeth and ruin a crankshaft when an engine is operated.

Inspectors check on inaccessible spots with the help of a mirror

Stepping Up Your War Production

WHETHER you work in a small shop or a large factory, you'll find you can contribute more to the war effort—and do it more easily—by following the suggestions listed below. Patriotic zeal is not enough. Precise workmanship is not enough. Ideas are not enough. A working combination of these three is necessary.

TOOLS AND MACHINES. These are important helpers. Treat them with care and respect. Keep machines scrupulously clean. Chips and dirt not only cause excessive wear—and therefore waste—but also inaccurate work. Micrometers and gauges should be checked frequently; they should not be left lying on the bench or table, but are to be kept in the tool chest. See that machines are well lubricated at all times.

ELECTRIC MOTORS. A motor breakdown can waste hours. Guard against overloading; check to see that drive belts are adjusted properly; keep chips and dirt out of motor housing.

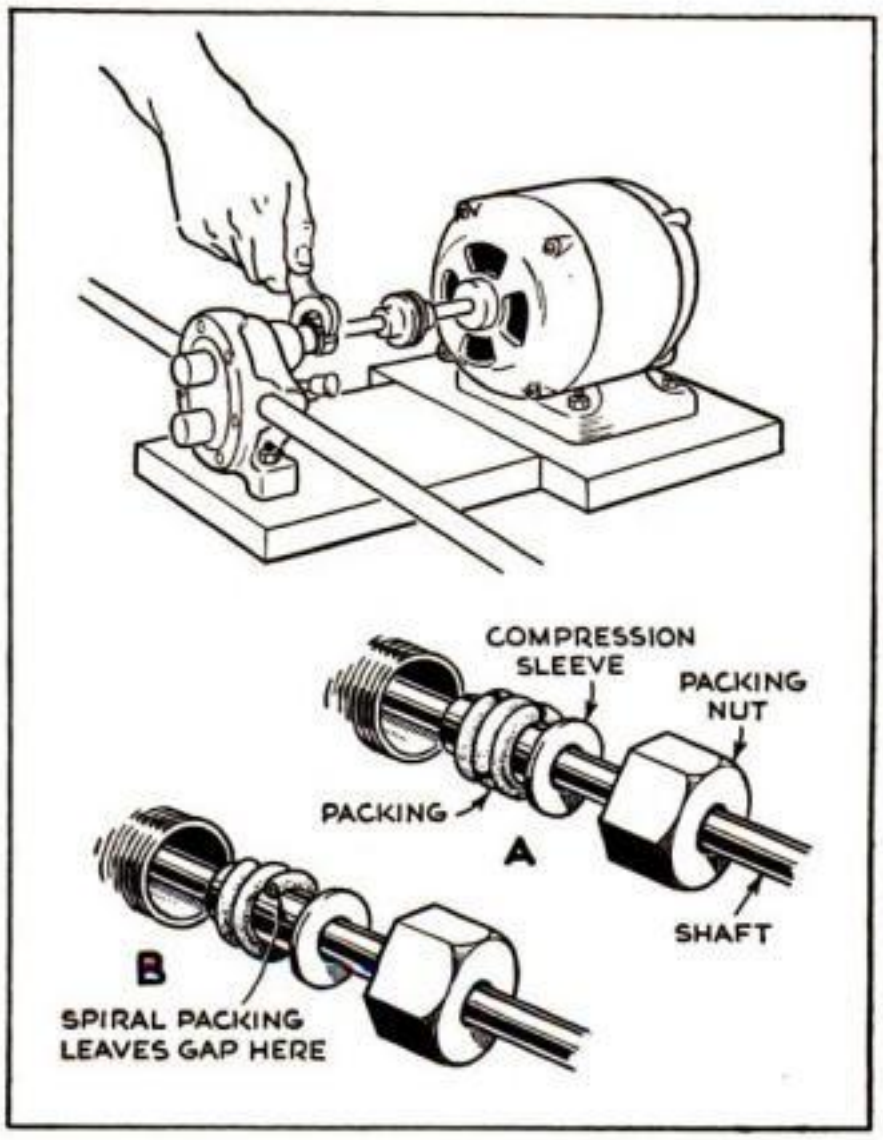
WASTE. Help destroy this saboteur of production. Conserve all materials, tools, and machines, from the lowliest cleaning rag to the most powerful dynamo.

MORALE. Promote good spirits and fellowship by assisting in staging rallies and meetings. If it's possible, have officers and men of the armed forces speak. Music or community singing during rest periods is another good morale raiser.

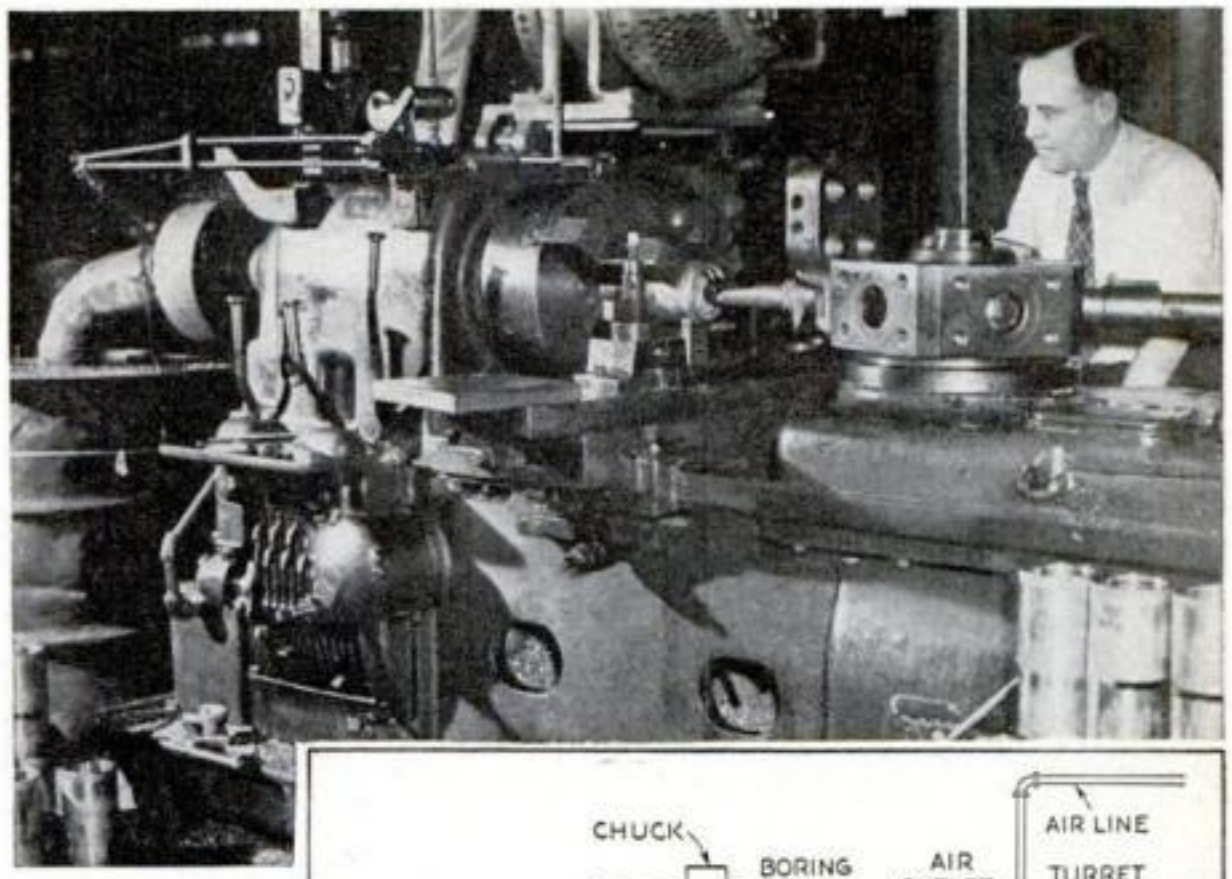
GOSSIP. Don't! Honest facts are the best weapons against two dangerous enemies: rumors and idle gossip. If there's a bulletin board in your department, keep it supplied with news clippings and governmental bulletins. If you don't have a bulletin board, ask permission to put one up. Encourage other workers to bring in news items.

IDEAS. In most factories there are suggestion boxes in which you can drop ideas that will promote more efficient work. Use them! See that the contents are turned over to your foreman at intervals. If there is no such box in your department, have one put up, even if you have to build it.

REPACKING A PUMP BEARING can be made a leaktight job by using single-turn lengths of packing, each formed into a split ring, as shown at *A* in the drawing below. The assembled pack is uniform in shape, thus permitting even compression and proper bearing adjustment. Spiral winding, as at *B*, makes a lopsided pack against which even compression is impossible. Place the rings so that their breaks are offset, and fill grease cups with water-pump lubricant—not ordinary cup grease, which is unsuitable for this purpose.—J. MODROCH.



AUTOMATIC SALVAGE of babbitt chips is accomplished with this pneumatic chip collector attached directly to a lathe used in machining the bore of babbitt-lined motor bearings. The lathe was originally piped for cutting oil, and this oil-piping system is connected with the shop compressed-air line. A sheet-iron pipe attached to the hollow spindle leads to a covered barrel into which the flying chips are blown when the air jet is in operation. Metal chips are thus kept free from floor sweepings and other contamination, and salvage is rated at 100 percent. The device can be adapted to any hollow-spindle lathe where salvage from boring jobs is desirable.



Metal chips, blown by compressed air, are salvaged as they are forced through the spindle into the barrel

A BURNED SOLDERING IRON needed in a hurry can be cleaned quickly and efficiently by holding the tip against a coarse garnet sanding disk or belt. This rapidly cuts below the pits and leaves the faces perfectly flat for retinning.

PLASTIC-TUBE LAMPS that carry illumination to the end of their bent light-conducting stems will be found convenient for inspection of inside turnings while they are still chucked in the lathe. The tips of these lamps are so arranged that they can be put easily into small openings.—W. T. BAXTER.

A STANDARD LUBRICANT CODE is being drawn up by the American Standards Association to assist inexperienced workers. The grade of grease or oil to be used in a given place on a machine is indicated by color. Oil caps and containers both will bear corresponding markings for identification.

S. A. E. STEEL NUMBERING SYSTEM [*SHOP PRACTICE*]

Following are the basic numerals for the various types of S.A.E. steel. The first digit of the standard number indicates the type of steel; the second generally indicates the approximate percentage of the predominant alloying element in the case of the simple alloy steels; and the final two or three (represented by dashes in the table below) indicate the average carbon content in "points," or hundredths of 1 percent. For example, 2320 means a nickel steel of 3.50 percent nickel content and .20 percent average carbon. Sometimes the prefix *X* is used to denote variations in the range of elements.

Type of Steel	Numerals (and Digits)
Carbon Steels:	1---
Plain carbon	10--
Free cutting (screw stock)	11--
Manganese Steels:	13--
Nickel Steels:	2---
3.50 percent nickel	23--
5.00 percent nickel	25--
Nickel Chromium Steels:	3---
1.25 percent nickel, 0.60 percent chromium	31--
1.75 percent nickel, 1.00 percent chromium	32--
3.50 percent nickel, 1.50 percent chromium	33--
Corrosion and heat resisting steels	30---
Molybdenum Steels:	4---
Carbon molybdenum	40--
Chromium molybdenum	41--
Chromium nickel molybdenum	43--
Nickel molybdenum; 1.75 percent nickel	46--
Nickel molybdenum; 3.50 percent nickel	48--
Chromium Steels:	5---
Low chromium	51--
Medium chromium	52---
Corrosion and heat resisting	51---
Chromium Vanadium Steels:	6---
1 percent chromium	61--
Silicon Manganese Steels:	9---
2 percent silicon	92--

In some instances, particularly with reference to corrosion and heat resisting alloys, it has been found necessary to depart from this system by varying the second and third digits of the number.

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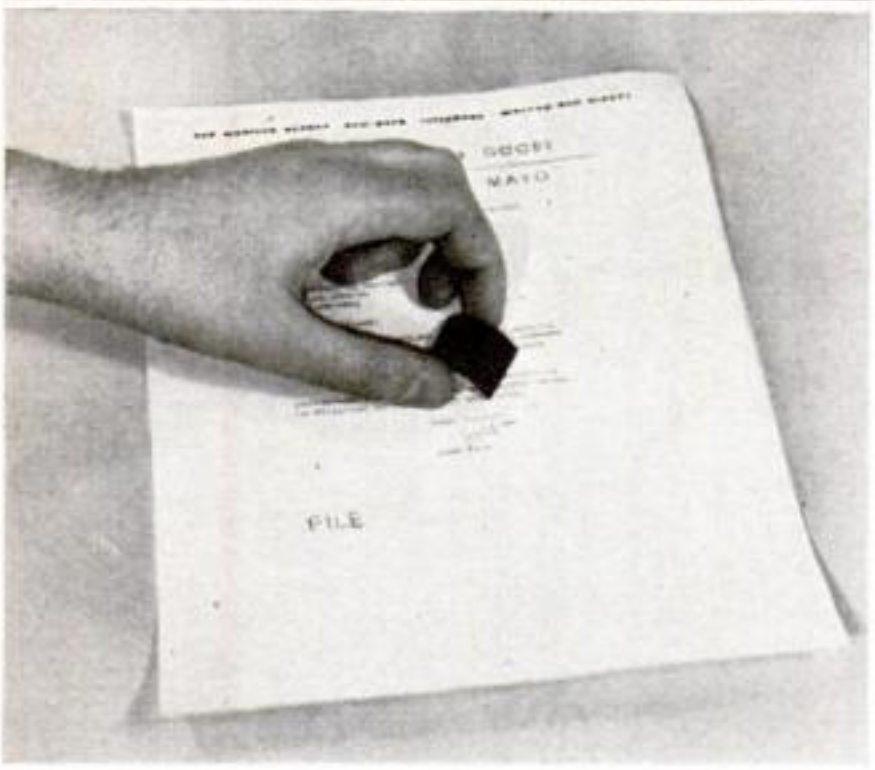


Microfilm

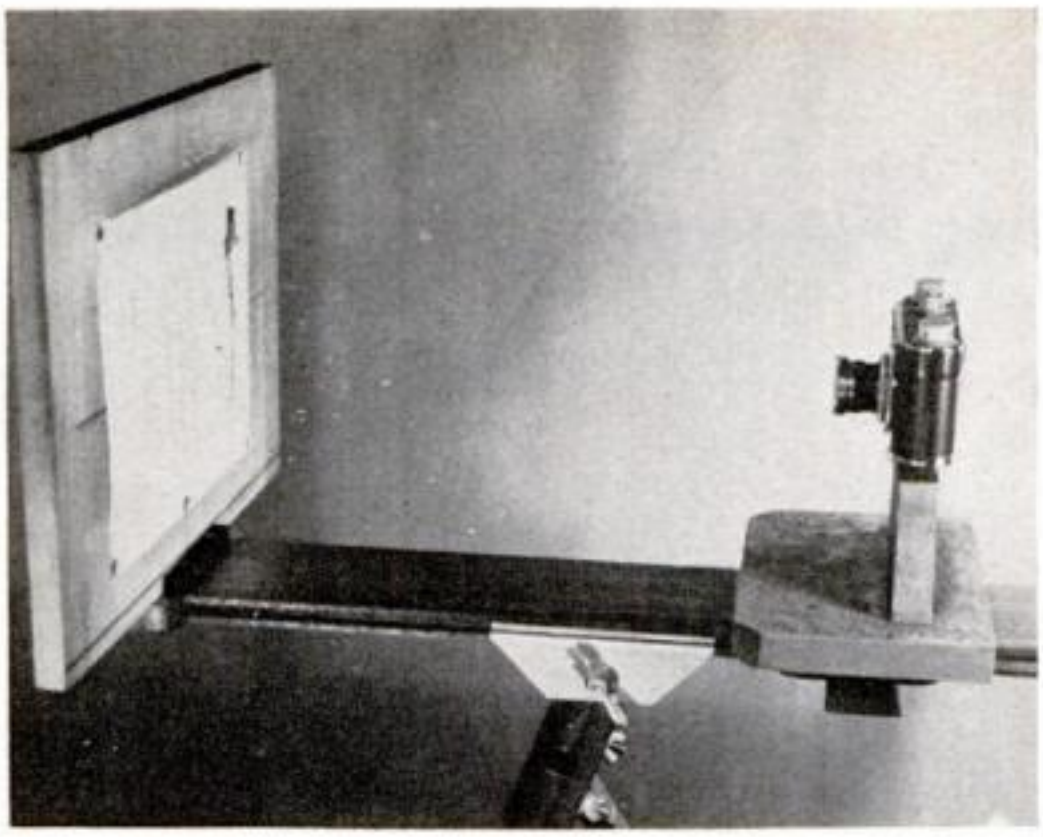
Miniature Camera Used

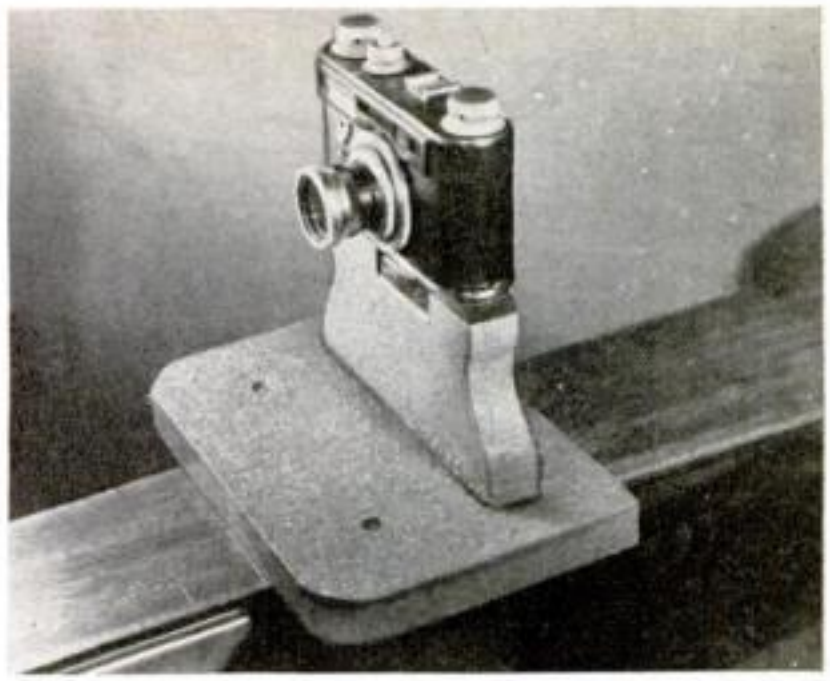
THE uses of microfilm are growing by leaps and bounds. Banks have long made photographic records of depositors' checks. Mail for service men abroad is now copied on film, so that a single reel bears hundreds of letters. Important documents have been filmed in England for safe storage against bombings. It may not be very long before a majority of business and professional offices will be keeping their records by this new method. The letter and record files that now take up considerable floor area will become a thing of the past. Tiny films will keep such records in a fraction of the space.

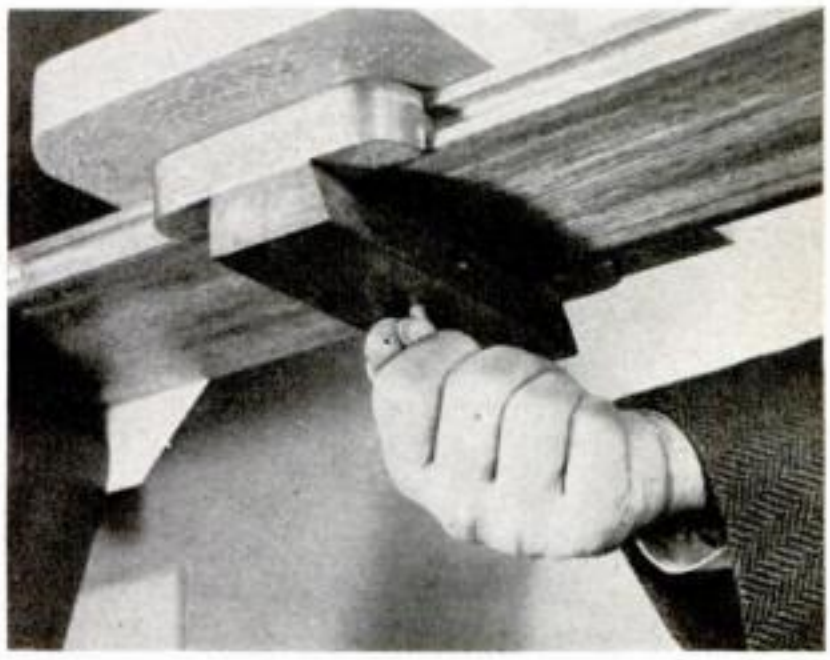
The making of small negatives sharp enough to be enlarged so as to reproduce the smallest of printing or line drawing may seem rather a difficult job, but if you rig up the right sort of equipment, shooting becomes so simple that anyone can learn how to do it in a short time.

One such unit for use with a miniature camera has been devised by Arthur C. Miller. It consists of an artist's easel, a 12" by 17" drawing board, and two blocks of wood for the camera support. All this came from an artists' supply store. The diagram shows how the items were put together to make the portable unit. That part of the easel normally used to hold the picture or canvas is clamped in a horizontal position, with the drawing board set upright and rigid at one end, and the blocks shaped into a holder for the camera that can be slid along the easel to various distances from the drawing board.

Mr. Miller's 35-mm. camera needs supplementary portrait lenses in front of the reg-







The two pictures on the opposite page show how lamps are used to illuminate the subject properly, and the relative sizes of a microfilm and the subject taken

Above is shown the upright part of an artist's easel clamped in a horizontal position to hold the drawing board and the sliding platform supporting the camera

Two photographs at the right show a simple method of constructing the camera support. A tripod screw holds the camera and a wing bolt secures the support

Copying Outfits

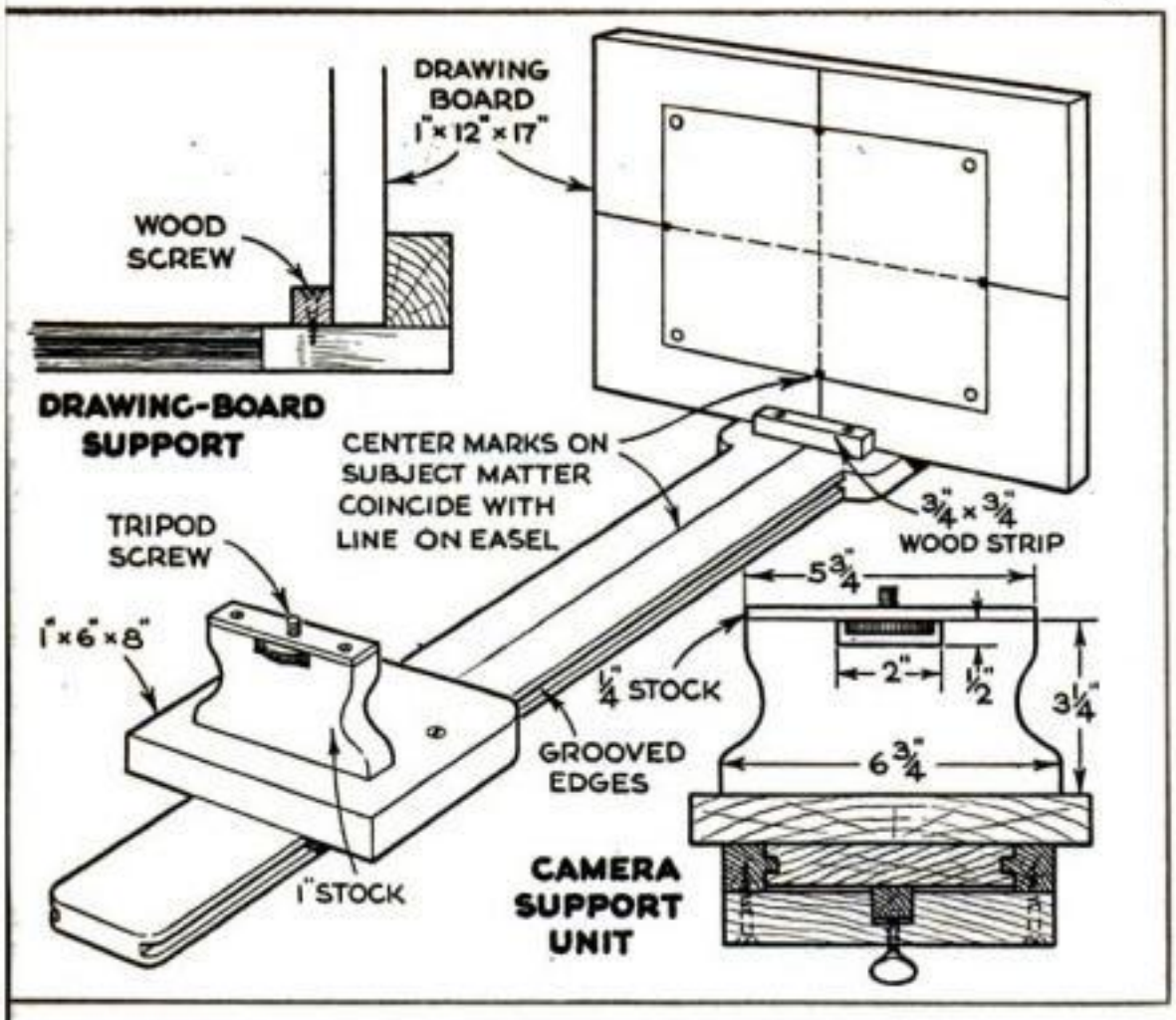
with Homemade Equipment Makes Permanent Photo Records

ular lens to allow for focusing at distances down to 10", and for covering a field from approximately 4" by 6" to 11" by 17". It takes a group of three lenses to cover this field, but for general work a No. 2 portrait lens will cover a field of approximately 6" by 9" to 10" by 14", which includes the average letter size of 8½" by 11". If you buy a portrait lens that does not fit your camera, get an adapter ring to fit your camera and the lens.

A chart may be had with each portrait lens showing the various focal distances, the lens setting for each, and the field the negative will cover at that distance. Adjustments consist of setting the focus scale in feet on your camera and sliding the camera support along the easel until it is the correct distance from the drawing board. For example, to microfilm a paper measuring 8¼" by 12", you will find on the chart that the closest corresponding field size is 8" by 12". You will also notice that the camera focus scale is to be set at 10', and that the distance from the lens to the drawing board upon which the paper is thumbtacked is exactly 16⅞". It is important to have the settings accurate for clear and sharp results. Distances can be marked on the easel for quick reference, making actual measurement of them unnecessary thereafter.

The drawing board must be at right angles to a line drawn down the center of the easel from the camera support, which must also be at right angles to the line. If a line is drawn vertically down the center of the drawing board and another horizontally across it at the same height as the center of the lens, it will be easy to center the material to be copied on the drawing board. Use white thumbtacks to hold white paper, or ordinary white adhesive tape.

Lighting is done with No. 2 photoflood bulbs and reflectors placed at 45 deg. so as to prevent reflections from entering the camera lens and fogging or spotting the



The construction of this portable and adjustable copying unit can be simplified greatly by the use of ready-made parts

negative. A photo shows this arrangement.

Another portable microfilm copying outfit has been designed and used by Willard Allphin, also with excellent success. This outfit takes the form of a carrying case that contains all of its parts when the setup is not in use. The four legs, which stand on top of the box and support the camera platform, are packed inside for carrying. They are then held in place by ordinary auto side-curtain fasteners, as is also the top platform which holds the camera, lens pointing downward, on top of the legs.

What becomes the bottom of the case when the outfit is being used has a piece of beveled ¼" plate glass set in it. The glass protrudes just enough to hold the material to be photographed flat between its surface and that of the table upon which the outfit is placed. All parts of the inside of the case which the camera can see reflected in the glass are painted a dead black. Other areas are finished in white. A pocket is built on the inside of the lid into which fit the electric cord, lens tube, and extra films.

Into the top of the case holes are drilled to take two dowels set in one end of each leg. The upper end of each leg is fitted with a bolt, which goes through the platform that supports the camera. Wing nuts on these leg bolts hold the platform rigid. The two wood saddle blocks in which the camera rests have pins that go through the carrying-strap holes of the camera, thus keeping it in perfect alignment. A leather strap fastened to one block is pulled down tight over the camera and fastened to the other block with an auto-curtain fastener.

The over-all size of a microfilm outfit of this kind will vary with the size of the field to be covered. The outfit shown covers a field up to 11" by 16½" in size, which is the

One portable copying outfit is completely contained within a case for ease in transportation

Demountable legs which support the camera platform above the box are doweled to the case lid

The picture below shows an operator putting a letter under the case for microfilming a copy

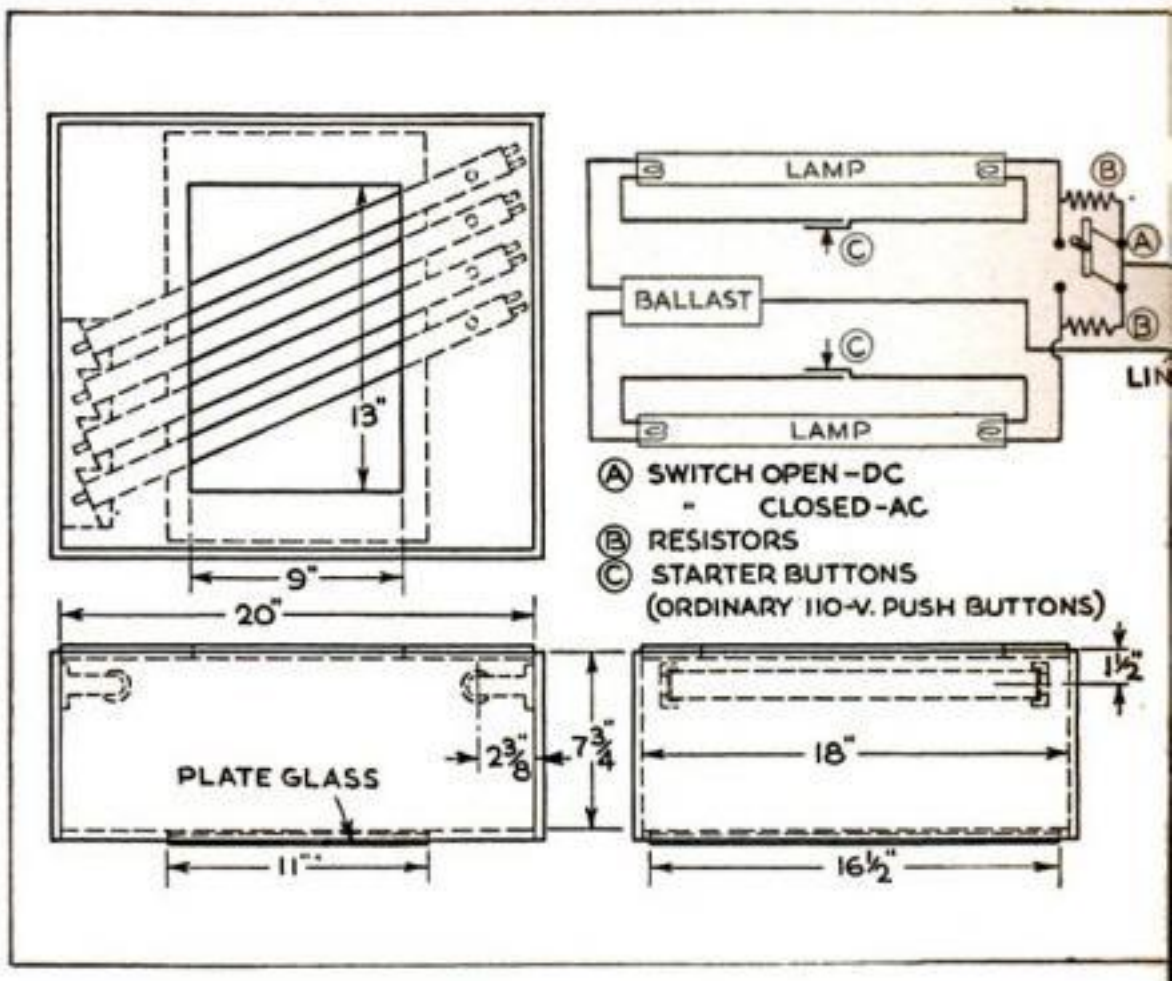
size of the plate glass. The distance from the bottom of the glass to the camera is 28". Two 14-watt, 15" fluorescent lamps are built in. The light is baffled to avoid high lights on the plate glass.

A wiring circuit for the two lights is shown in the diagram. It will be noted that the two lamps are wired for both A.C. and D.C. If it is attempted to start the lamps on A.C. with the toggle switch on the D.C. side —that is, open—nothing will happen. If, however, it is attempted to operate the lamps on D.C. with the toggle switch on the A.C. side, the lamps will burn out.

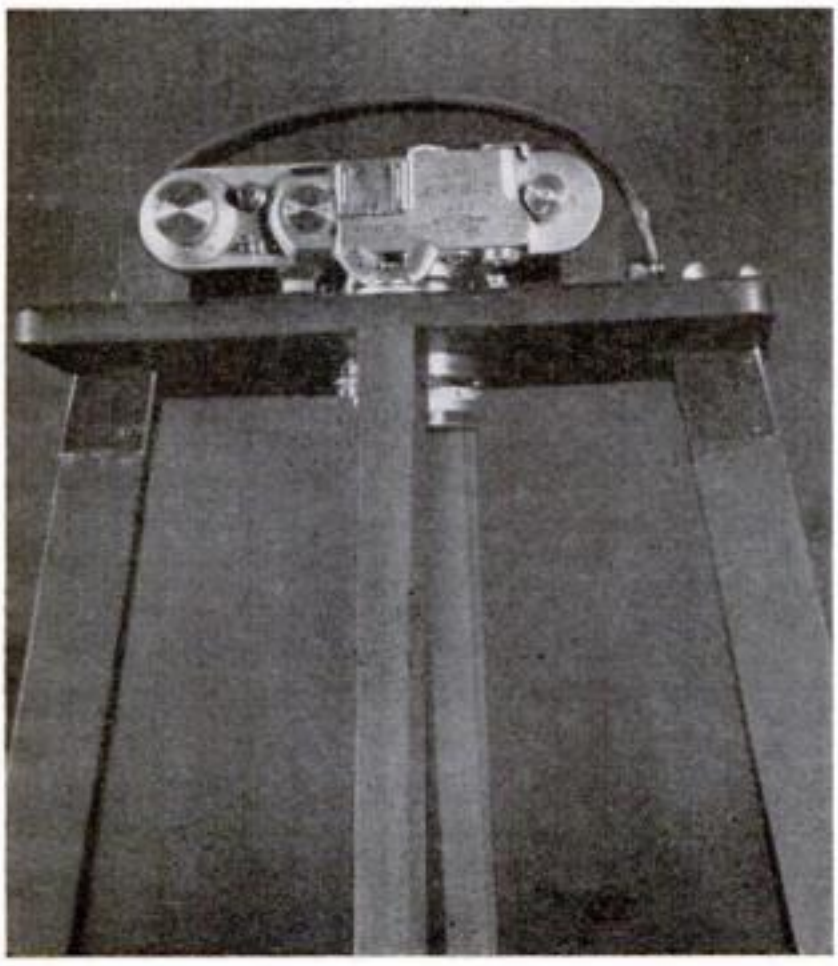
When the material to be photographed is on one side of the sheet only, an extra white sheet under it will increase reflection and contrast. If a paper has printing on both sides and the reverse side has a tendency to show through, a piece of black paper under it will help give a clearer result. Filters are not needed for ordinary work, but if special occasions arise, say to eliminate a color, use a filter which transmits that color. On the other hand, to emphasize or darken a color, use a filter which absorbs that color.

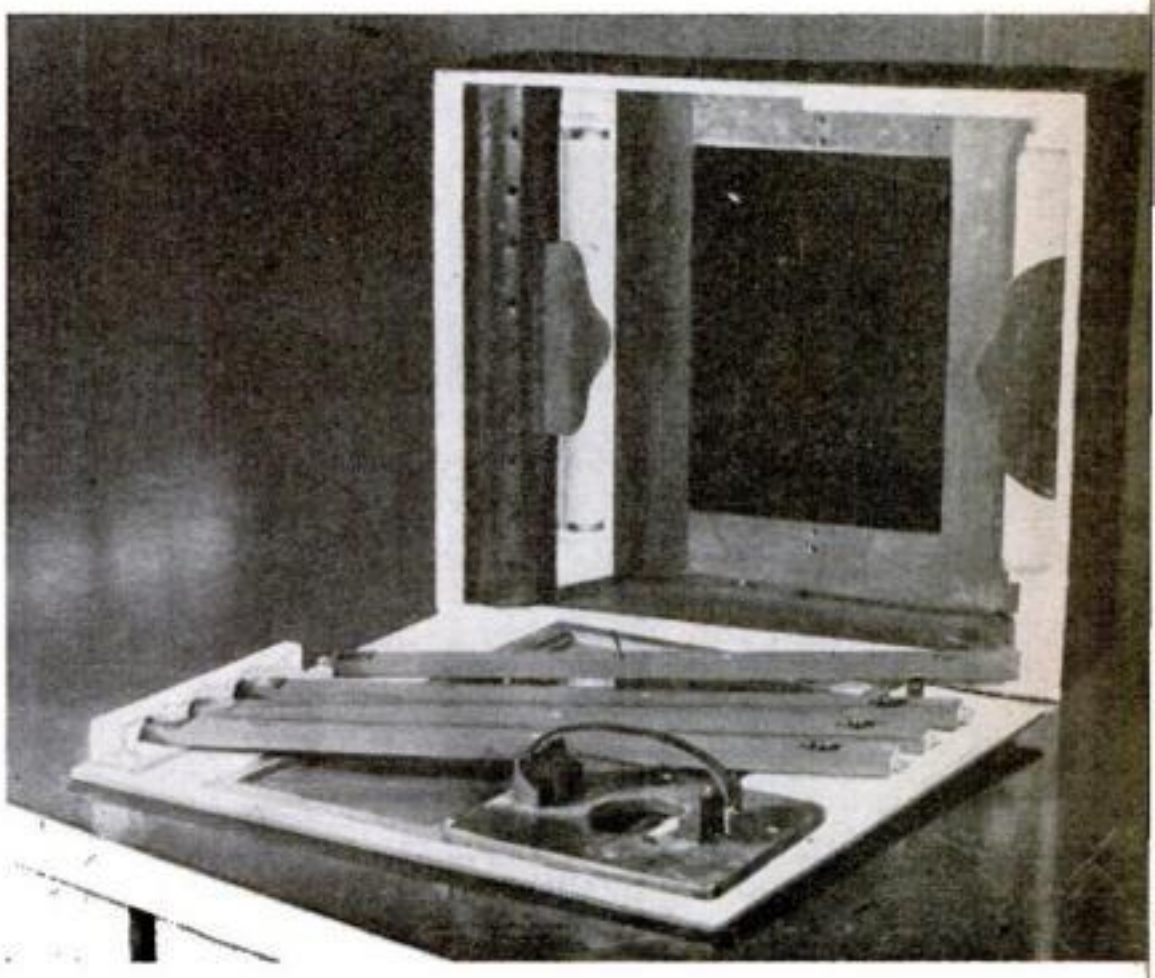
In general, it might be wise to standardize on one film and developer. There are special films made for this purpose. The choice of developer will depend upon whether you copy photographs occasionally and want to maintain normal contrasts, or whether you are doing letters and drawings exclusively and want maximum contrast. An all-around film will give twice the contrast in one developer that it will in another, both developers being entirely suitable for the uses intended. Different films will take stops from f/6.3 to f/12.5, and exposures from ½ to 1 second.

Microfilming is done on either 16-mm. or 35-mm. films, and the negatives can be enlarged at will on photographic paper to provide individual copies, or the films can be thrown on a screen for temporary or group reading. Any kind of camera using small film can be adapted for this work.



At the right is a drawing showing how the case is constructed, and below the drawing is a picture showing how the legs and camera platform are carried. The picture directly below illustrates the camera in place on its platform

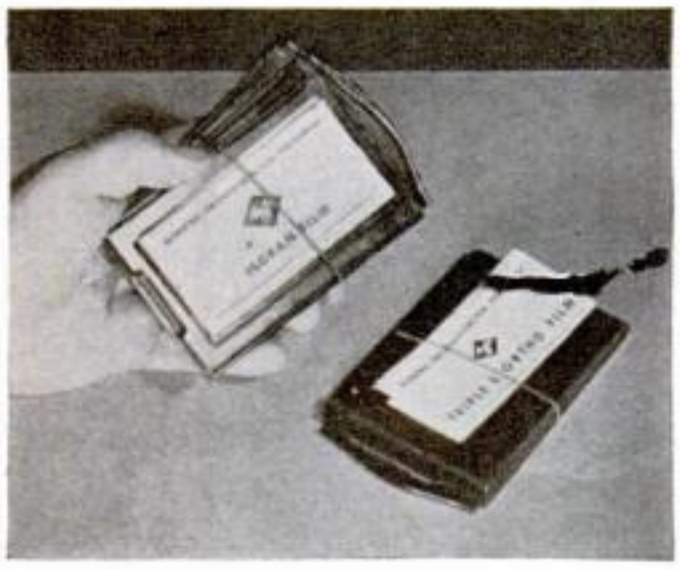




When two exposures are made on the same sheet of film, the pictures will be upside down to each other like this

After the slide is pulled about halfway out of the holder, a white line is drawn across the back side

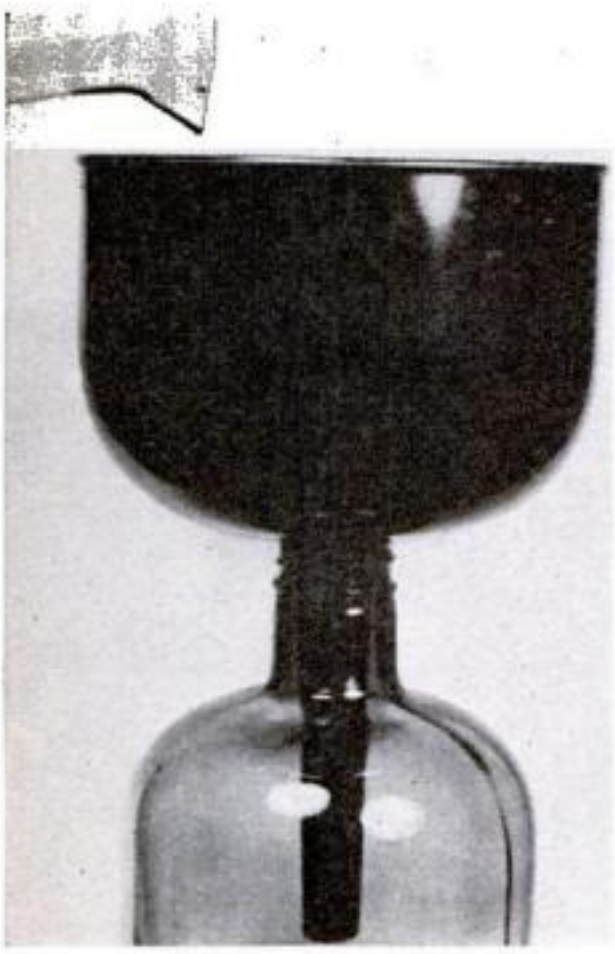
COLOR FILM in professional cut-film sizes is rather expensive for the average amateur to use, but by a simple trick two pictures can be made on one piece. Pull out the slide of an empty film holder until slightly less than half of the exposure area is visible. With the slide in this position, mark a line on the back of it with white ink. If the bottom edge is curved, straighten it by grinding or filing. Put a radius on both sides of this edge so that the slide will fit easily in the bottom slot. Film is loaded into the holder with the notches in the upper right-hand corner. A picture is exposed by drawing the slide out to the mark; the film is then reversed end for end by reloading it in the darkroom, and the second picture taken.—FRANK MCCARTY.



IN LOADING HOLDERS with different types of cut film, a good way to identify them is to snap a rubber band around each group and slip the instruction sheet from the film package under the rubber band. After exposure, the holders can be kept with a duplicate instruction sheet marked "exposed" to prevent errors in timing development and so forth.—LOUIS HOCHMAN.

AN EFFECTIVE film squeegee can be made in a few moments at very little cost from a pair of metal film tongs and a windshield-wiper blade. Make a lengthwise bend or crease in each side of the tongs and place half of the wiper blade in each crease. Hammer the creases around the two blades to hold them firmly in place. When the wet film is hung up to dry, a quick stroke with this handy squeegee removes all excess moisture. The better the wiper blade you use, the more efficient your squeegee will be. One with several edges is good.—ROBERT SCOTT.

MOONLIGHT PHOTOGRAPHY. The mellow glow of a full moon was the only light shining on this country home when the unusual photograph at the right was taken. A time exposure of seven minutes was made at a lens stop of f/5.6 on a high-speed panchromatic film. The shutter was closed whenever the gleam from car headlights passed before the camera, and opened immediately after to continue the exposure.



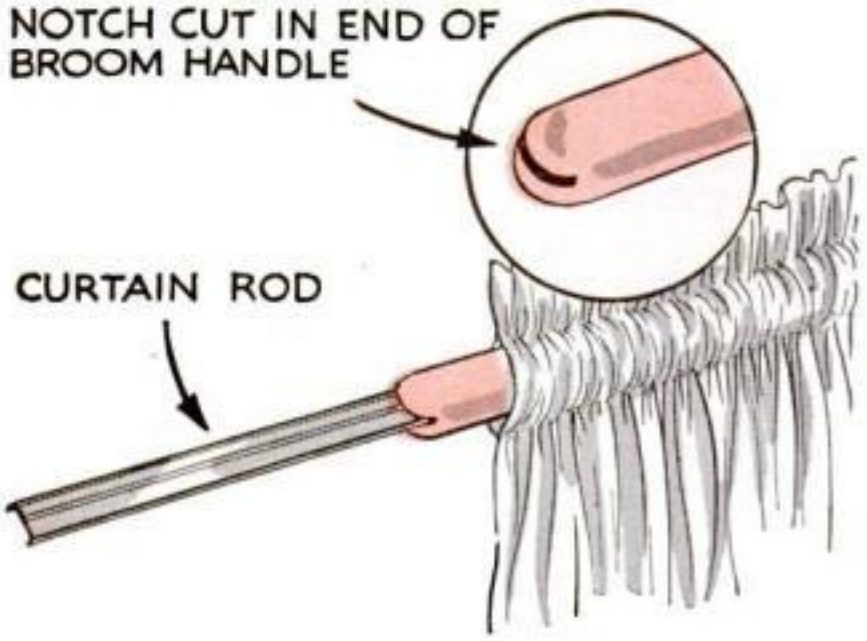
TIME is saved in filtering photographic chemicals when the funnel used is the plastic or glass upper bowl from a vacuum-type coffee maker (above). This enables you to pour a quart or more of the liquid into the funnel at one time. If you don't have one of these around the house, you can purchase the single piece at almost any department store. For filtering, a piece of absorbent cotton or a regular coffee filter can be used.—C. H. COLES.

CUTTING PHOTOGRAPHIC PAPER in the darkroom is easier if white ink or luminous paint is used to touch up the more commonly used markings on the paper-cutter board. The scored lines you will wish to point up will vary with your particular requirements, but for the average user, white lines at the 2½", 3½", 5" and 7" lines will be found most useful.—ED REYNOLDS.

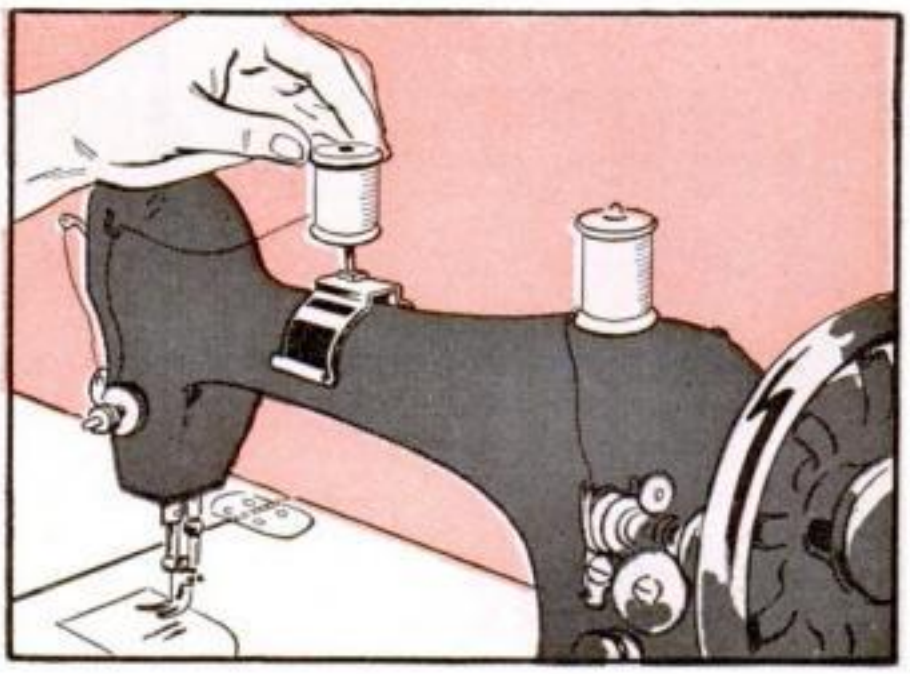
FLASH BULBS are precious photo items these days, even to professional photographers. Now, more than ever before, the bulbs you have on hand should be tested in order to avoid wasting film and losing pictures. A simple tester can be made quickly by bending a wire clip to fit around a small flashlight cell and hold at its other end a 6-volt radio pilot bulb. Touch the center button of the cell to the bottom bulb terminal and the pilot-bulb terminal to the screw base. The small lamp will light with a faint glow if the flash bulb is good Test the bulbs in a dimly lighted place.—L. H.

KEEPING THE

To make one of these individual picnic trays, attach a 12" plywood square to a 22" broomstick, one end of which is pointed so it can be pushed into the ground

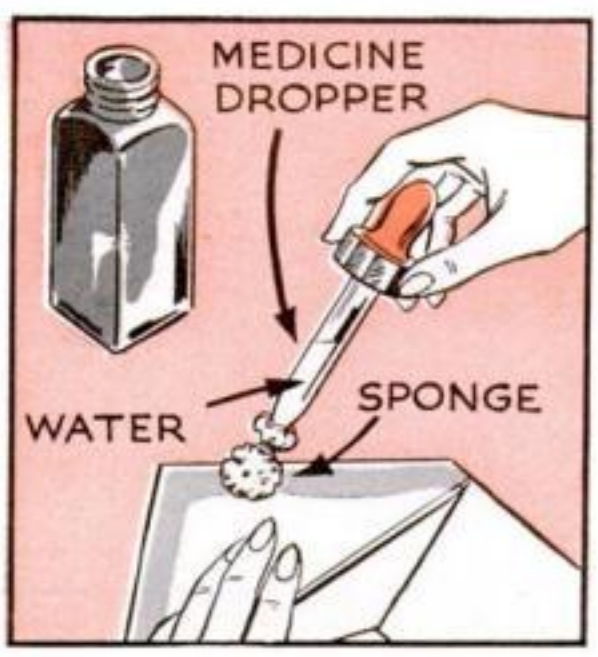


Curtains are placed on flat rods with a broomstick notched as above. If your rods are of the round type, bore a hole in the stick instead



An auxiliary spool holder that slips over the head of a sewing machine is made by attaching a 2" bolt to the spring clamp of a bicycle flashlight holder

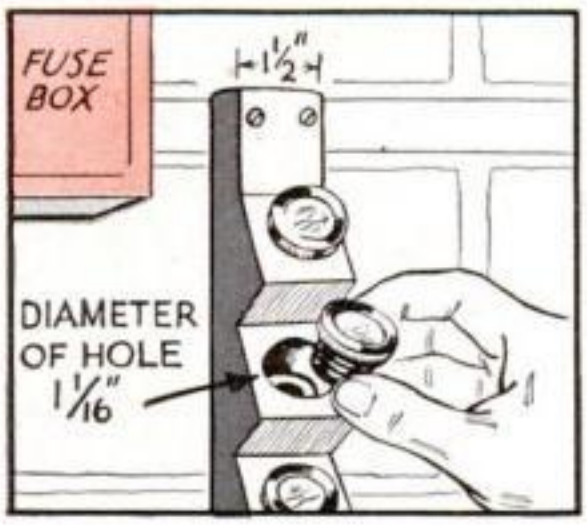
You can lengthen the life of your precious rubber gloves by placing wads of cotton in the fingertips



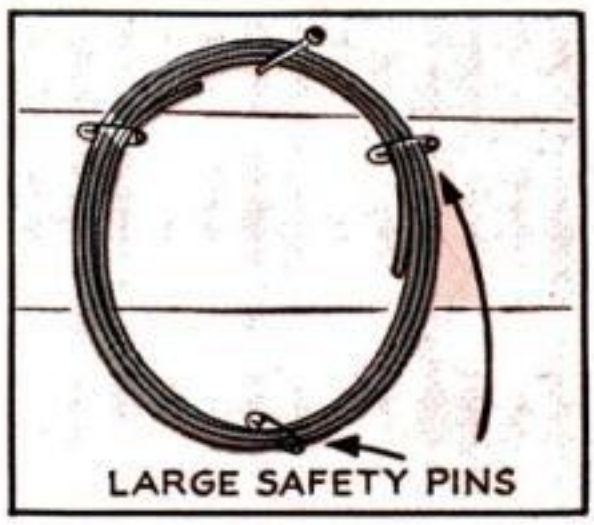
A leakproof envelope moistener is easily made by tying sponge to a medicine dropper

For kitchen hot-dish mitts, cut several thicknesses of calico to shape; then quilt them together

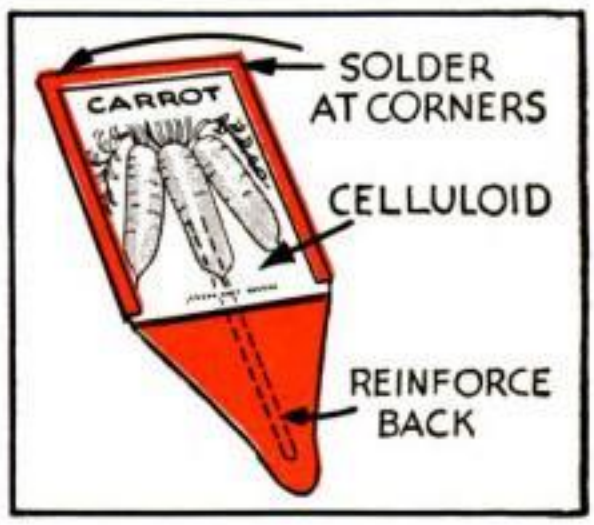
HOME SHIPSHAPE



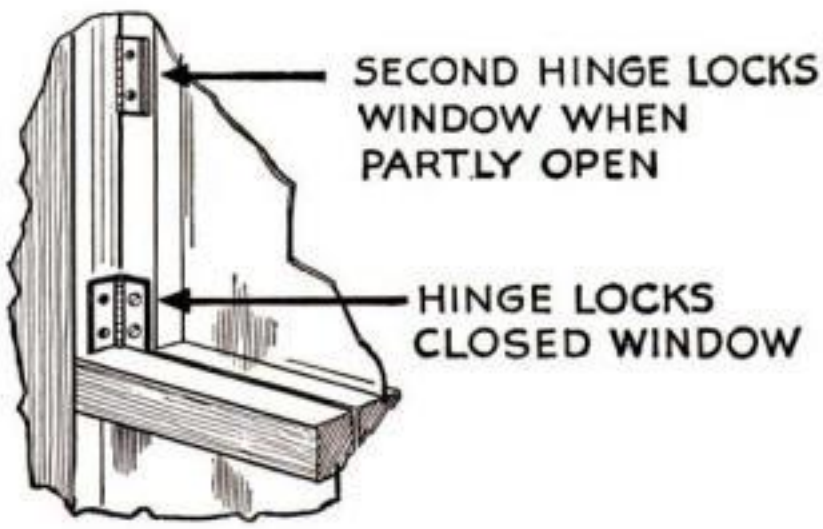
A fuse-plug rack is shown above. Cut the body in steps and bore fuse holes 1" in depth with an expansive bit or a fly cutter



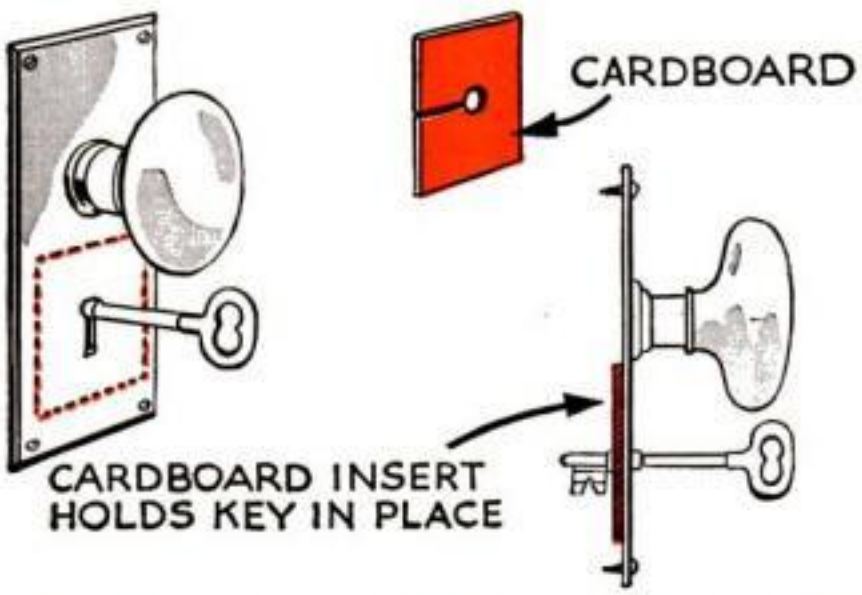
Coils of wire can be kept from tangling or unwinding if large-size safety pins are placed as is shown in the drawing above



Garden markers of tin plate and celluloid are waterproof. Solder a tin strip to the back for reinforcement, and paint to suit



Small hinges make efficient window-sash locks. Screw one on each side of the inside face of the upper sash, with hinge joints close to the parting strip. To lock the window, open the hinges



Keeping a key in place in a lock is simple if you remove the lock plate, insert the key in the keyhole, then slip a slit piece of cardboard directly behind the key and replace the plate

The convenient electric-razor holder above can be made of wood from a fruit crate, or any ordinary ¼" stock. This holder also keeps the cord hanging free and prevents it from being kinked

Model Scenery and How to Plan It

Grading Railway Layouts from an Engineering Viewpoint

By DAVID MARSHALL

RAILWAYS must accept the world as they find it, dealing with every obstacle of nature in the most economical way possible. Every curve results from some irregularity of the land over which the railway operates, whether it be a ragged coast line, a mountain range, a winding valley, or an impassable waterway. We can set down as a first principle of railroad engineering the fact that curvature is determined by terrain.

The model railway, however, is built within the four walls of a room, and it curves simply because it cannot go through them.

JUSTIFYING THE LAYOUT. Having designed a satisfactory layout, you must now destroy the evidences of your four walls, and invent a completely different set of reasons why your track twists and turns as it does. You must get back of the layout and create geographical conditions that would have made your railway what it is had these conditions been created first. For example, if you wish to have your track curling through hills or following the winding course of a river, the hills and river must be drawn to scale upon the basic plan of your railway. In short, all scenery must be justified.

This involves a very close examination of the layout, a searching out of all the characteristics that provide clues to the lay of the land. On the grown-up railways, terrain determines curvature; on model railways, curvature determines terrain.

INTEGRATING TRACK AND TERRAIN. You must make certain that the rise and the fall of the land accords with your track elevations —roughly, of course, or else you can never have any cuts and fills or bridges. You will have to determine the way a hill slopes and exactly how steep the slope will have to be. The entire landscape must be allowed to develop naturally from your layout. Never introduce any single feature of the landscape gratuitously, but allow all to develop out of the stuff inherent in your layout, so that in the end you may have a terrain that is not only unified but integrated with the railway itself. Scenery cannot be improvised or haphazard. It has to be the inevitable conclusion drawn from the swing of your tracks.

Model-railway terrain consists of two parts: the foreground modeled in plaster, and the background painted on the wall, and these should be consistent with each other in order to form a logical whole. In other words, the painted background should "read out of" the modeled foreground; both foreground and background should be so well integrated that the whole character of one will explain and be explained by the whole character of the other.

CUT AND FILL. We start with the grading of the railway, the first element in model-railway scenery. We shall consider this only from an engineering viewpoint, leaving the structural problems and the modeling of plaster terrain to be dealt with later.

A grade is the prepared earth on which the ties are laid, or in a larger sense the vertical alignment of the railway. There are upgrades, downgrades, and level grades, and where two of them merge, the track passes through a leveling-off or vertical curve, which is called a transition grade.

The grade results from an equal balancing of cut and fill. Railway builders must of course take the terrain as they find it, but within the limits of their capital they seek more advantageous levels through hills and across valleys. Where the amount of earth to be excavated equals the amount required for the embankment work, at that level is the grade. In the words of the engineering book, "the grade splits cut and fill," as shown in Figs. 1 and 2.

It follows that you cannot build your model railway flat upon a table top, for the table top would represent water level, and if your grade lay there, you could not have a hilly terrain without immediately setting up a false engineering picture of cuts without corresponding embankments. Your average grade must lie several inches above the table top, figuratively speaking, thus leaving room not only for upgrades and downgrades but also for embankments, and for the inevitable concomitant of the embankment—the bridge.

Bridges we shall come to later on, but there is one type of bridge we must deal with at once—the culvert. Any bridge over a gap of less than 6′ (Fig. 3) is called a culvert by railroad men. An embankment must have at least one of these, to allow a free passage of water from one side to the other; otherwise the embankment would become a dam, liable to be undermined or to be swept away the moment any large amount of water collected on one side of it. A bridge should be built for every valley, ravine, or gorge, and a culvert for every little fold and hollow the railway crosses.

Scenery, carefully planned and skillfully built to scale, adds a realistic touch to any model pike

The amount of earth excavated from the cut must equal the amount that is used in both embankments

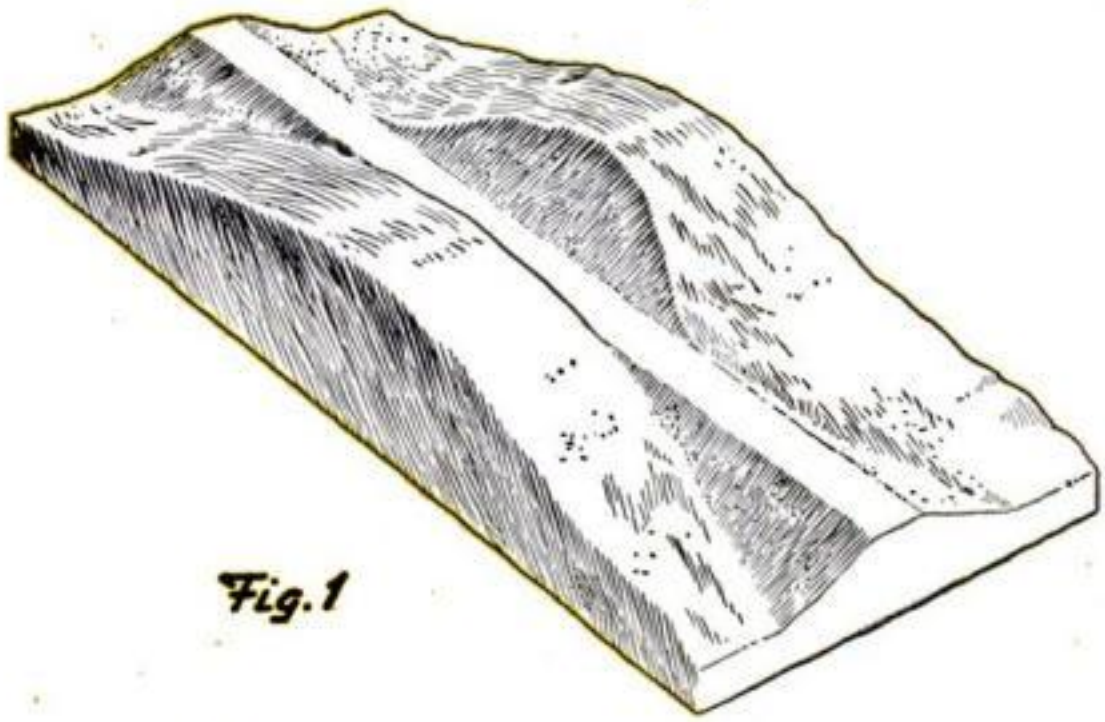


Fig. 1

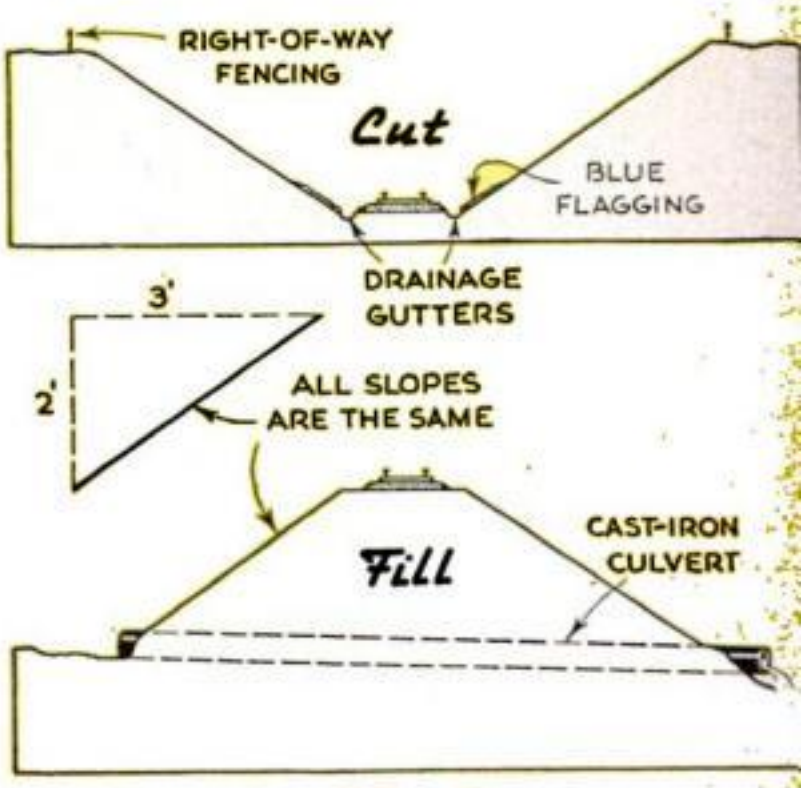
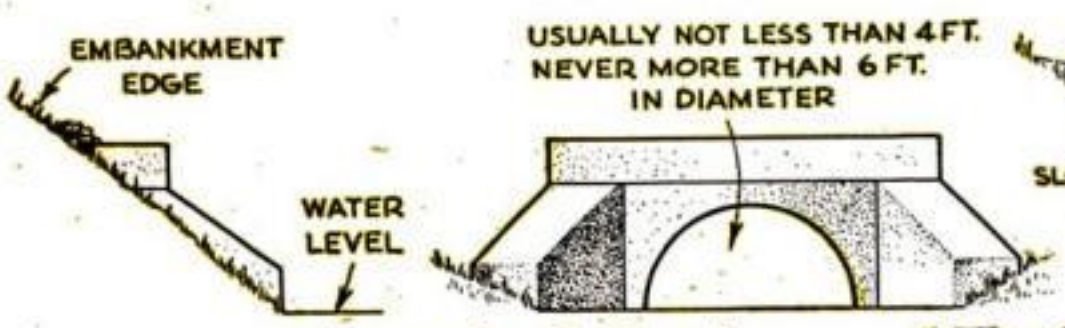
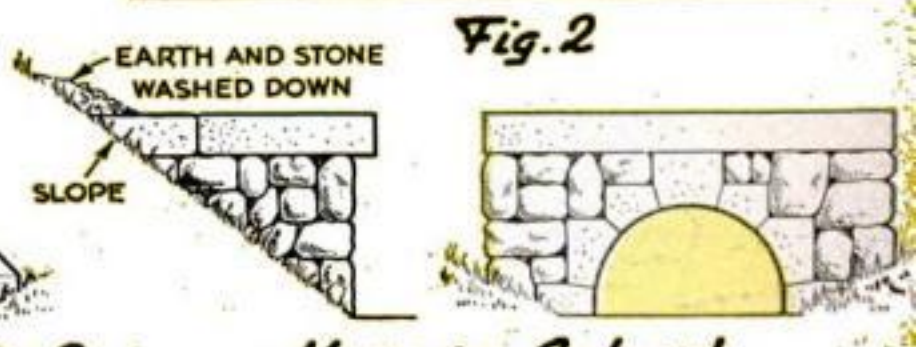


Fig. 2



Concrete Culvert

Fig. 3



Masonry Culvert

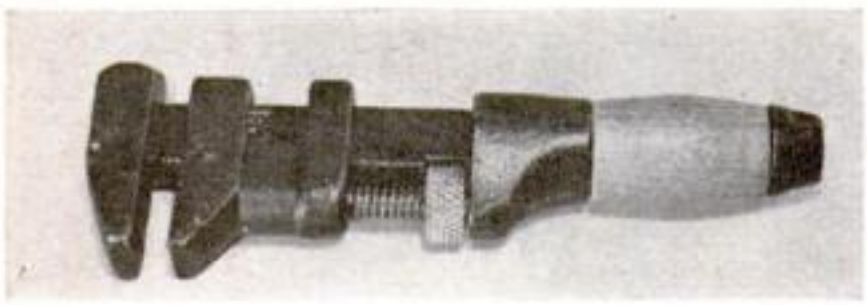
Question Bee

THERE is much evidence to show that wrenches in the 18th and 19th centuries were generally made of wrought iron and were hardly known to any but professional mechanics. It was not until after the middle of the 18th century and the introduction of agricultural machinery that wrenches came to be used universally. Little is known about wrenches before 1700, although there is no doubt that there must have been some contrivance existing that was at least similar to a wrench. Today, however, there are countless varieties of wrenches. Can you recognize the types shown on this page? After writing your answers, turn the page upside down and see how many you have named correctly.

ANSWERS

1. Self-adjusting wrench
2. Monkey wrench
3. Stillson or pipe wrench
4. Flat wrench
5. Allen wrench
6. Boos adjustable open-end wrench
7. Tap wrench
8. Alligator wrench
9. Tool-post wrench
10. Box wrench

1 .....



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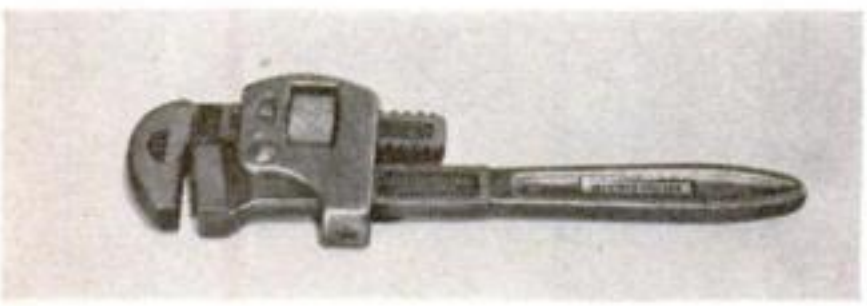

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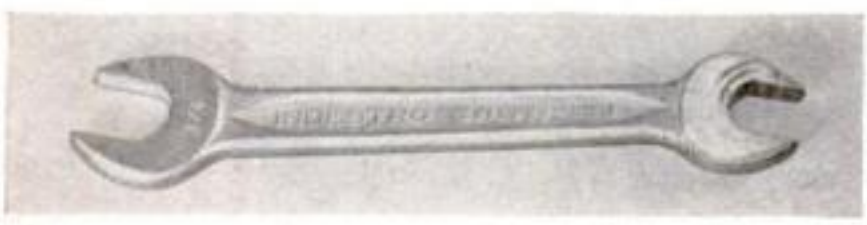

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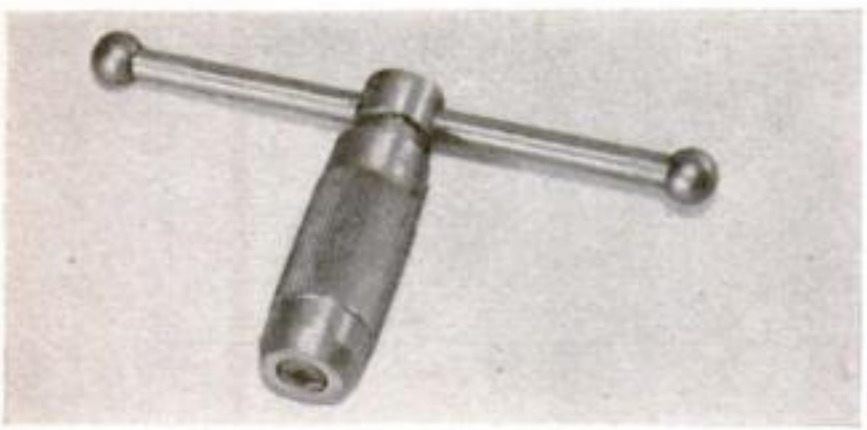

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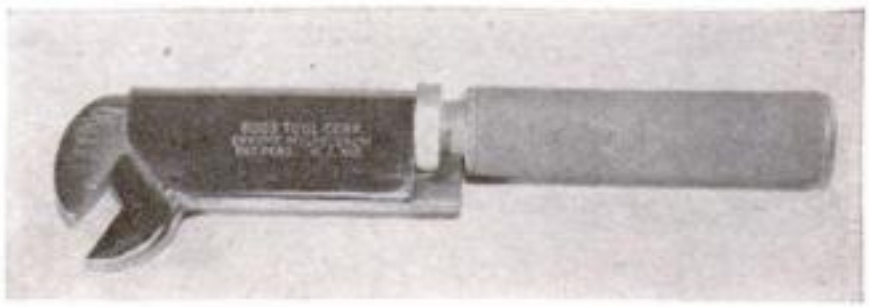
9 .....



6 .....

8 .....

10 .....

All that is required are three simple reagents, individual droppers, a few nails, and a small magnet

SORT YOUR SCRAP WITH A Metal-Testing Kit

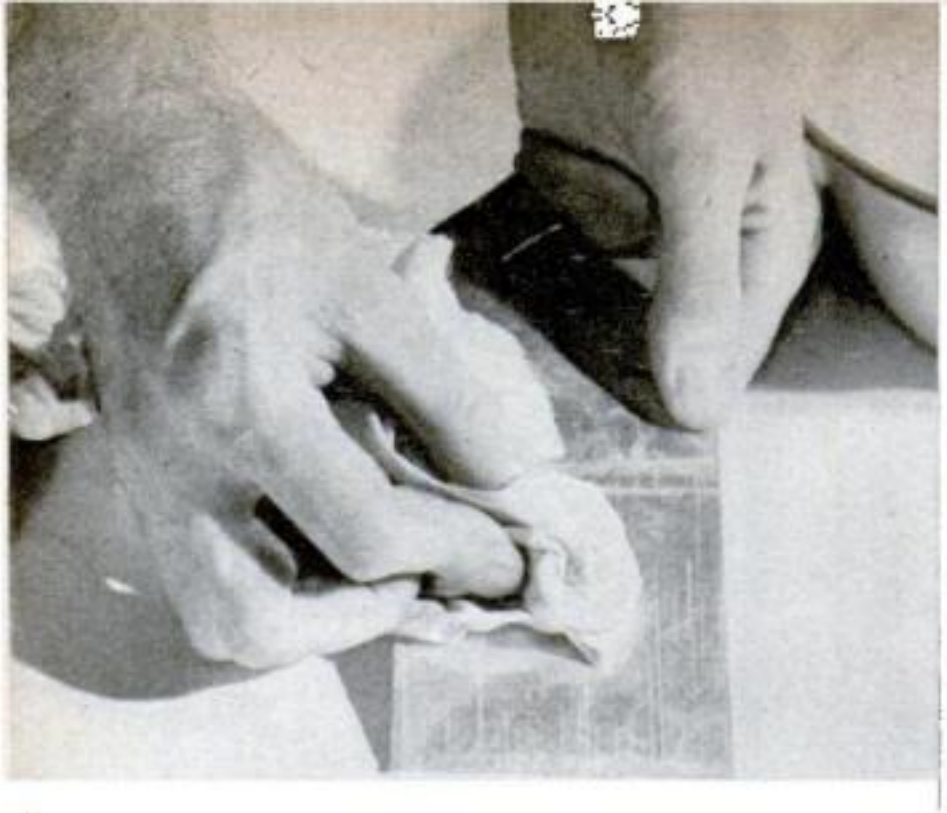
WHAT YOU CAN DO FOR VICTORY

By KENNETH M. SWEZEY

FOR the householder who wants to know just what kind of scrap he has and how it might be used in the war, chemists of the International Nickel Company suggest a simple testing kit which should prove valuable also to manufacturers with scrap for sale, civic scrap-drive agencies, and dealers. It costs little to assemble a few ounces of concentrated nitric acid, a like amount of distilled water, and a solution of 10 grams of cupric chloride in 100 cubic centimeters of concentrated hydrochloric acid. For apparatus, you need only three droppers (one for each reagent), a few iron or steel nails, and a small bar or horseshoe magnet.

With this simple equipment you can make a quick and positive identification of eight different metals and alloys, as shown in the table on the following page. Some of them look like others, but contain entirely different metals or the same metals in different proportions. Monel metal, for instance, is made up principally of about two thirds nickel and one third copper. Chromium-nickel stainless steel contains 18 percent and 8 percent of these same valuable metals, respectively.

Methods of carrying out the tests are as simple as the equipment. The first test is



THE NITRIC ACID TEST. First clean the metal with an alkali, such as washing soda, to remove all grease. Apply two drops of nitric acid, and note the speed of the reaction. Now dilute the acid with water, a drop at a time, watch for any change in color, and compare it with the table below

for magnetic properties, which can be determined by suspending the magnet on a string, so that it is free to turn, and then bringing the metal toward it. Monel metal is usually magnetic at room temperatures, but if this quality does not show at once, a bath in ice water or a freezing mixture will cause it to be revealed.

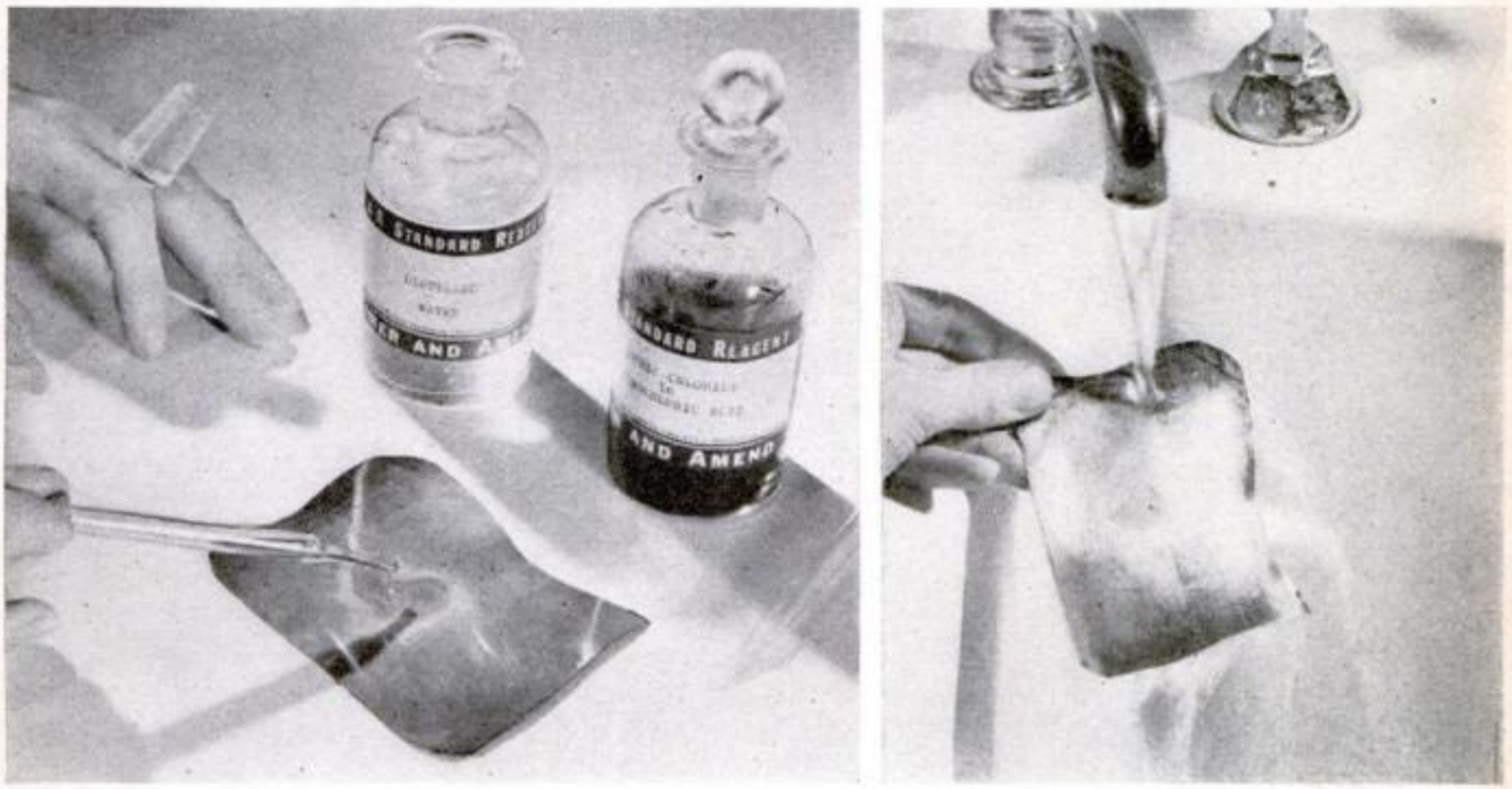
Clean the spot where the nitric acid test is to be made, using washing soda or another alkali. Apply one or two drops of concentrated nitric acid, and wait a few minutes to note the reaction, if any, and the speed. Dilute the acid with three or four drops of distilled water, one drop at a time. If the solution turns green or blue, proceed with the nail test for copper. Keeping the nail in contact with the metal, you rub the end of it in the nitric acid, which has been diluted with a few drops of distilled water. If copper is present in the alloy being tested, it will be deposited either on the nail or on the surface of the metal, under the acid solution.

The fourth test, in which a drop of cupric chloride in hydrochloric acid is applied, is described on the opposite page. Its purpose is to distinguish Inconel—an alloy containing 80 percent nickel, 14 percent chrome, and 6 percent iron—from those chromium-stainless steels mentioned before which contain only 18 percent nickel and 8 percent copper.

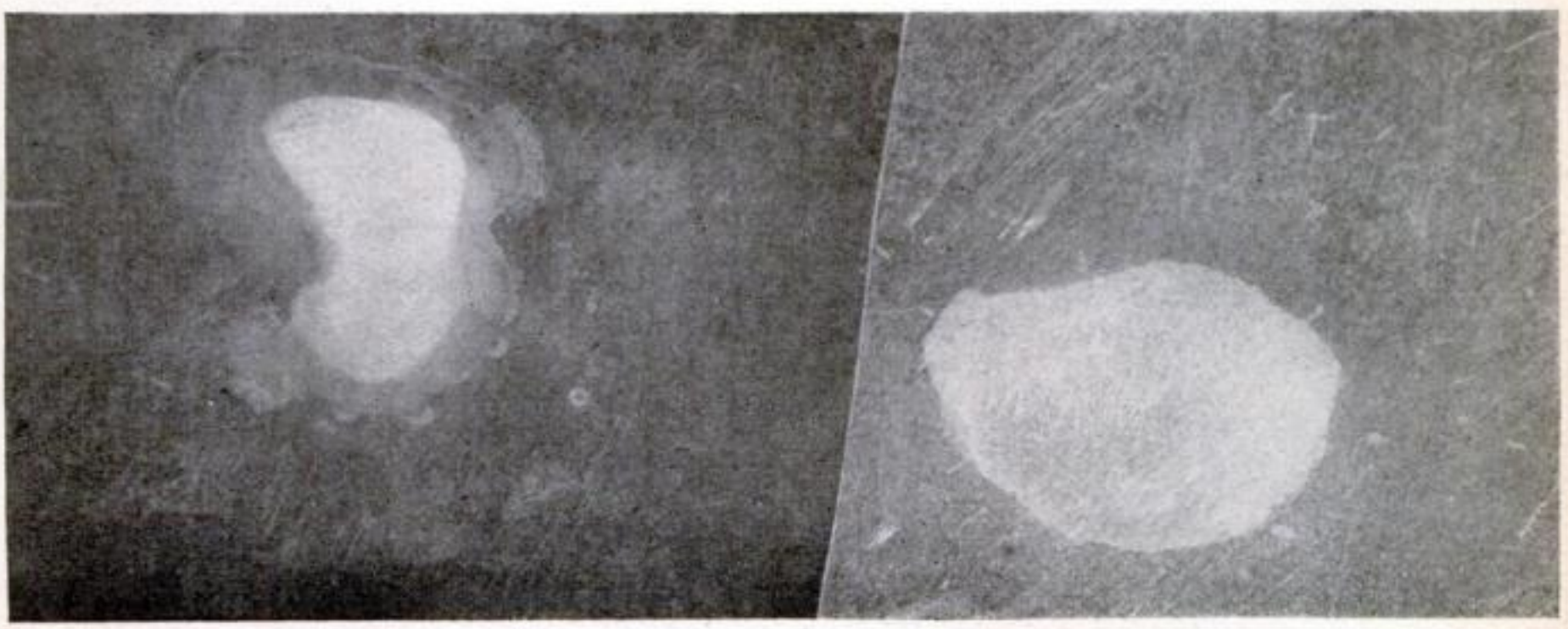
QUALITATIVE TESTS FOR IDENTIFYING SOME COMMON WHITE METALS AND ALLOYS

MAGNETIC TEST	NITRIC ACID TEST			Iron Nail Test for Copper	Drop Test with Cupric Chloride in Hydrochloric Acid	Material Probably Is
Reaction to Magnet	Reaction to Conc. Acid	Reaction to Acid after Dilution	Color of the Solution			
Magnetic	Reacts Slowly	Reacts Slowly	Pale Green	No Copper Plates out	Not required	Nickel
Magnetic (slightly)	Reacts	Reacts Slowly	Greenish Blue	Copper Plates out	Not required	Monel
Non-magnetic	Reacts	Reacts	Bluish Green	Copper Plates out	Not required	Copper-Nickel Alloy containing less than 60% Nickel, e.g. Nickel-Silver
Magnetic	Reacts Slowly	Reacts	Brown to Black	Not required	Not required	Steel or Cast Iror
Non-magnetic	Reacts Slowly	Reacts	Brown to Black	Not required	Not required	"Ni-Resist"
Magnetic	No Reaction	No Reaction	Colorless	Not required	Not required	Straight Chromium Stainless Steel
Non-magnetic	No Reaction	No Reaction	Colorless	Not required	Copper deposits when drop is diluted	Chromium-Nickel Stainless Steels e.g. "18-8"
Non-magnetic	No Reaction	No Reaction	Colorless	Not required	No deposition of copper occurs	Inconel

When brought into contact with the concentrated nitric acid, the metal being tested will do one of three things: react swiftly, slowly, or not at all. If there is a quick reaction, it will appear as at right above. If, however, there is a slow reaction, or none whatever, it will appear as at left above



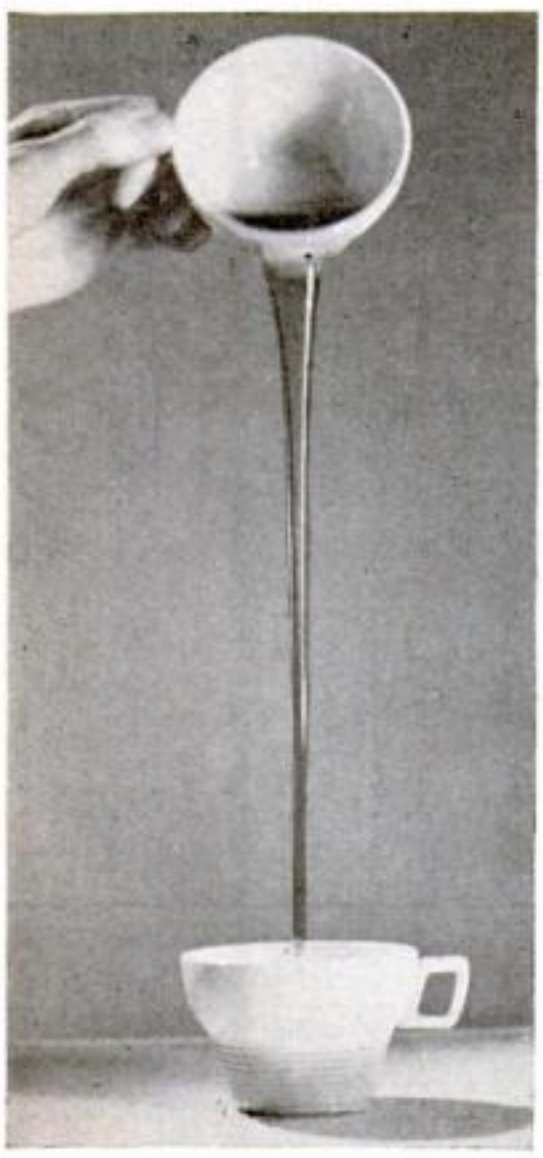
DROP TEST with cupric chloride in hydrochloric acid distinguishes between Inconel and chromium-nickel stainless steel. A drop of the reagent is applied to the cleaned metal surface and allowed to remain for two minutes. Three or four drops of distilled water are added, and the solution washed off. If sample is "18-8" stainless steel, copper is deposited (left, below); if Inconel, there is no deposit



home EXPERIMENTS

A PAPER BALLET. Put some bits of tissue paper in a dry glass bottle with a metal cap; then challenge your friends to make the papers dance without moving the bottle. For best results, the bottle should be no more than 3″ high. To perform the trick, shuffle your feet about on the carpet; then touch the top of the jar with your hand. If sufficient static electricity has been produced by the friction of your shoe soles on the carpet, the accumulated charge on your body will make the papers leap from the bottom to the top of the jar several times.

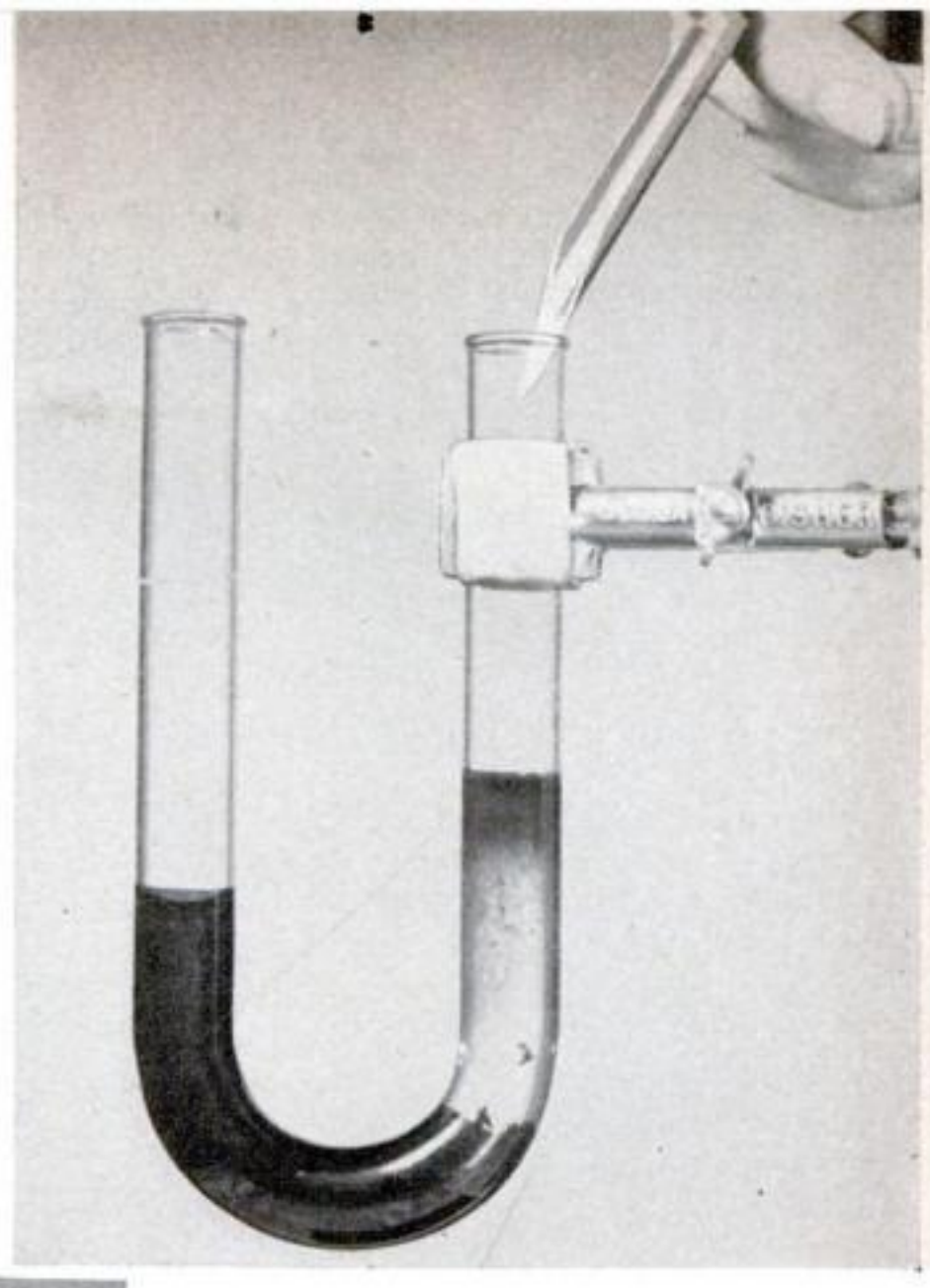
"REPELLING" MAGNET. Make a loop of several turns of copper wire, joining the ends together, and suspend the loop so that it hangs balanced, as shown. Now thrust a bar magnet or a straight electromagnet into the loop. The coil will be mysteriously repelled. The reason is that the magnet, by induction, sets up in the coil a momentary magnetic field of like polarity to that of the magnet.

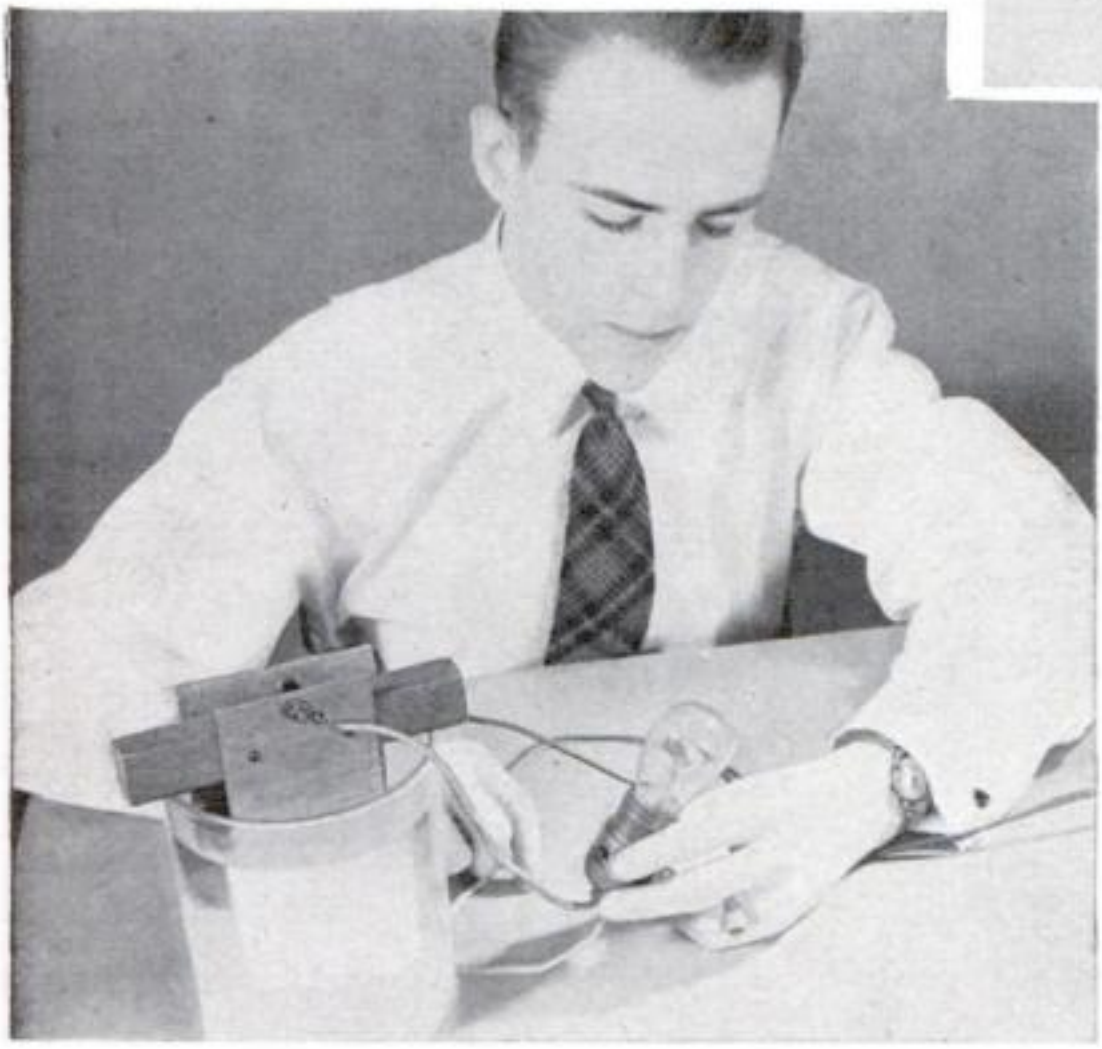


WHY DOES A LIQUID STREAM TAPER? Pour any viscous liquid from a height, and the stream will taper from top to bottom. Since an equal amount of liquid must pass any point in the stream, how do you explain this difference in the size of the flow? The answer is that the thinner part of the stream is flowing faster, being accelerated by the force of gravity.

SURFACE TENSION can be demonstrated with a cork weighted so as to float in an upright position about one fourth out of a jar of water. Fasten a small ring of wire to it a fraction of an inch above the top. If you press the cork under water so that the wire is just submerged, the surface tension pulling down on the ring will keep it there despite the buoyancy of the cork. Now dip a piece of soap into the water near the side of the jar. The soap, on dissolving, lowers the water's surface tension, and up pops the cork.

HERE'S A MAGIC LIQUID that, unlike water, does not seek its own level. The U-tube shown in the photograph contains a colored liquid that rises an inch or more higher in one branch of the tube than in the other. You can prove to your friends by rocking the tube gently that there is no hidden partition holding the liquid in this odd state of unbalance. The secret of what seems a gravity-defying mystery is that there are two liquids colored alike in the tube. The heavier liquid is carbon tetrachloride, colored with a few iodine crystals. The lighter one is water, colored to match with crystals of potassium permanganate. These liquids will not mix. A few grains of sodium bisulphite dropped in will decolorize the potassium permanganate, as shown, and clearly reveal the relationship between the two liquids.





CONDENSING STEAM CAUSES A VACUUM, as can be seen by boiling some water in a flask until all air has been driven out. Pour the water out and insert a stopper with a glass tube drawn into a jet at one end. Invert the flask as shown below, placing the outer end in a tumbler of water. In a few seconds a fountain of water will spurt through the jet, continuing to rise in the flask until it is almost full. Since the steam has driven out all the air, the condensation of steam produces a vacuum.

ELECTROCHEMICAL RECTIFIER. To change A.C. to D.C., immerse a plate of pure aluminum and a plate of lead in 1 oz. aluminum phosphate dissolved in 8 oz. water. When these are connected in series with a 110-volt A.C. house line and a small argon bulb, A.C. will be allowed to pass first, as evidenced by the lighting up of both plates of the tube. However, one plate will grow dimmer and finally go out, indicating that half of each A.C. cycle is being cut off. Here is the explanation: a film of aluminum oxide is built up on the aluminum electrode, due to the liberation of oxygen about it. This film will not allow current to pass from the aluminum into the solution, but permits current to flow the other way into the plate.

IDEAS for HOME OWNERS

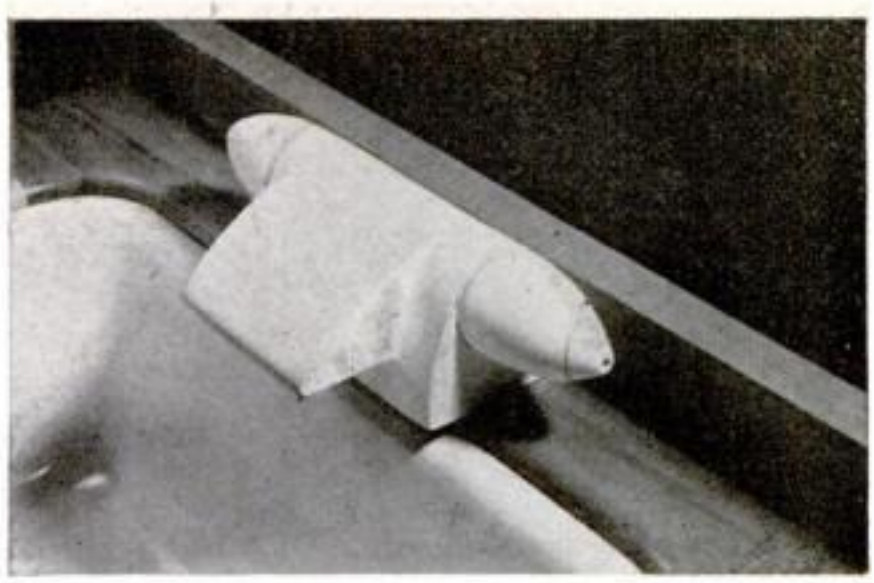
THIS TANK PUMP and incendiary-bomb fighter has been recently developed for effectively combating fires. It has its own storage tank with a capacity of 5 gal. and will throw a stream of water approximately 40'. The apparatus is constructed almost entirely of wood and plastic, is extremely light in weight, convenient to carry, and can be operated easily by just one person. Its synthetic hose is made of woven cotton-and-paper fabric covered with a plastic sheeting. The device has been subjected to tests in leading laboratories, and the standards of performance and durability revealed in these tests were reported as being exceedingly high.

PAINTBRUSHES ARE RECONDITIONED with this brush cleaner that is noninflammable, will not evaporate, and is used as it comes from the can. Simply soak the brushes in the cleaner, then rinse them out in water. Harmless to bristles and settings, the brush cleaner can be kept for an indefinite period of time. It does not have the acrid smell of some other cleaners, and is economical, since only a small amount is necessary for cleaning each brush.

LONG LIFE FOR LINOLEUM is possible by painting the surface with a new, clear, gloss-finish fluid (not illustrated) which renders it impervious to stains, hot water, alcohol, or grease. It should not be used on new linoleum, since a "breaking-in" period of about three months is necessary before the coating may be effectively applied.

CLOGGED DRAINS can be opened with a new device that utilizes the water pressure at the faucet. It is simple to use and works automatically. One end of the cleaner is inserted in the drain and the other end attached first to the hot-water faucet. A small stream of water should be run through the tubing, and the flow gradually increased. The hot water expands the pipe, separating the grease and corrosion from the metal. The end of the cleaner is then attached to the cold-water faucet, and the water turned on full force. The cold water contracts and breaks up the grease and corrosion into small particles, and the water pressure forces these particles down the drain. This drain cleaner can be used effectively to clean bath tubs, kitchen sinks, laundry tubs, lavatories, and other appliances that may have clogged drains.

THE CERAMIC FAUCET shown at the right substitutes for prewar metal types. This new modernistic faucet operates similarily to a radio dial. You "tune in" on hot or cold water by turning the dial-like knobs on either side. The ceramic used in the faucet is heat resistant, so that it will not crack even when very hot water is turned on immediately after the cold water. The only metal part is a small brass spring employed in the control knobs. The rest of this unusual faucet is made of non-critical materials.



AN AWNING PRESERVATIVE in the form of a colorless liquid is simply rubbed into the canvas (below). So applied, the liquid impregnates the cloth fibers, and is said to strengthen them and to make the fabric repel water and resist sun and mildew. It can also be used on canvas auto tops, boat sails, tents, canvas furniture, and the like. Before using the preservative, the surface to be treated should be cleaned of all surface dirt.

CONCRETE IS HARDENED by a transparent, penetrating liquid that can be put on with a broom or a brush. The product is said to make concrete waterproof and to prevent the formation of dust due to crumbling, besides increasing wear resistance. It can be used on brick, stucco, plaster, and unglazed tile as well.

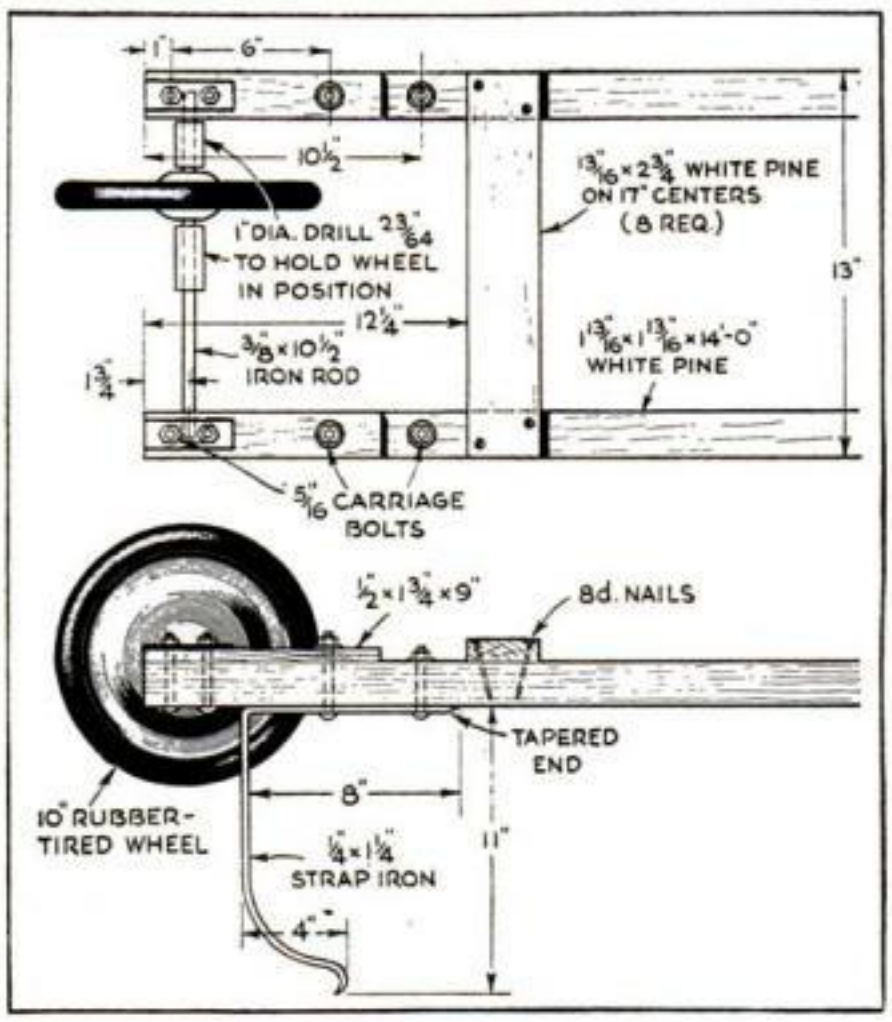
FIVE-WAY NOZZLE. Attached to a hose, this nozzle produces five different streams, ranging from an 18′ spray to a 40′ flow. Made of rustproof metal, it has a spike that can be driven into the ground or used as a handle, and an adjustable disk against which water strikes to form a spray.

Sod Prevents Soil Erosion

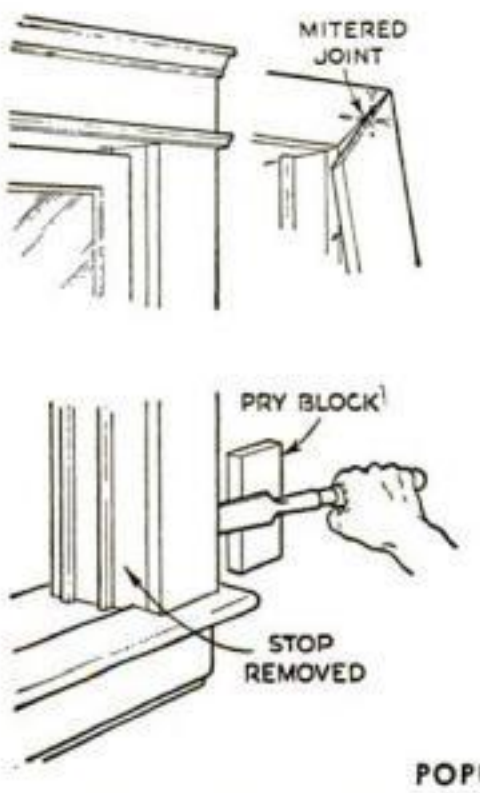
JUST as straw is spread on newly graded road banks to prevent erosion by rain, so sod may be packed around the base of a large tree to keep rain rushing down the trunk from washing out a newly seeded lawn. In the photo, a protected section successfully weathered a heavy rain, while the unprotected area was ruined.—J. M.

Wheel Mounted on Ladder Aids in Hooking It over Ridge

ONE MAN can hook this wheeled ladder over the ridge of a roof. The wheel and its axle can be taken from a child's discarded tricycle and attached to the ladder as shown. Set a ground ladder to reach above the roof and ascend this, carrying the other. Place the end of the wheeled ladder on the roof and roll it up the pitch until the wheel goes over the ridge. Then flop the ladder over so that the hooks catch.—A. D. S.



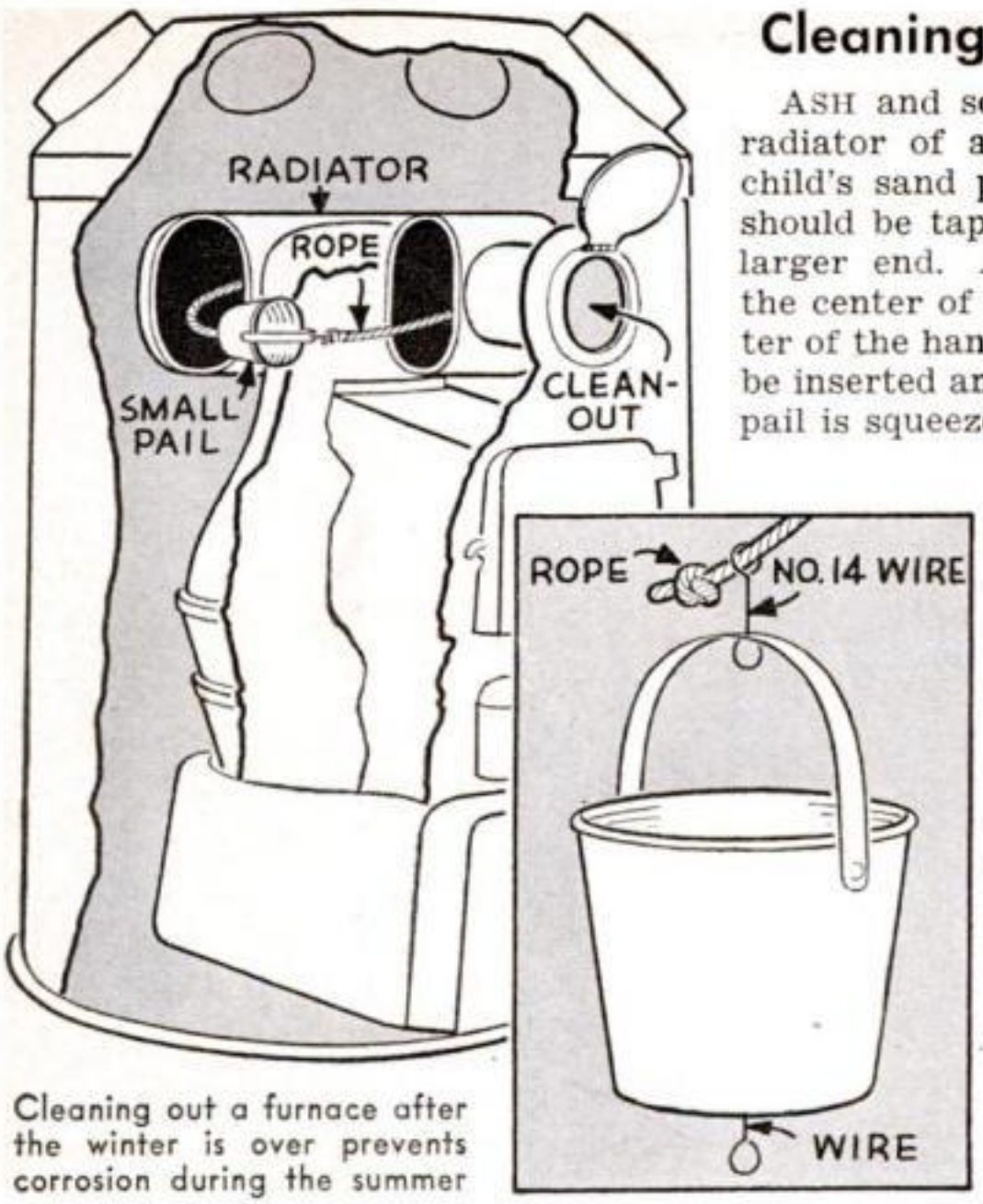
REPLACING DAMAGED SASH CORD [*SHIPSHAPE HOME*]



A GREAT many double-hung window frames are built without removable facings on the pockets. If a cord breaks, or if it comes loose from the sash or weight, the repair cannot be made without first removing a casing. This should be done after the stop is removed by prying the outer edge with a chisel braced against a strip of metal or thin plywood to prevent damage to the plaster. Loosen the lower end first, continuing to the top. The edge nailed to the pulley stile can then be worked loose easily. If the casing is mitered at the top, there may be nails driven in from the top and side edges, which will split the casing if care is not taken. Sometimes these nails can be driven all the way through with a fine nail set, so that the casing can be brought away at the top with a downward and outward prying motion. After the cord is replaced, pull the nails out from behind the casing and nail it back as if it were new material. Set the nails and putty the holes to match the paint.

POPULAR SCIENCE MONTHLY SHOP DATA

Cleaning Your Warm-Air Furnace

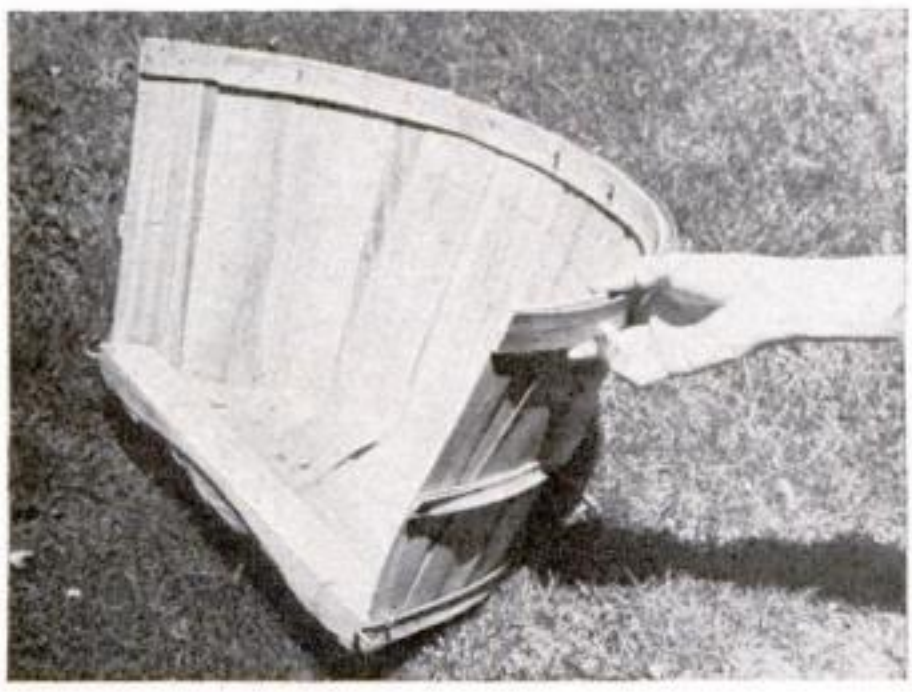


Cleaning out a furnace after the winter is over prevents corrosion during the summer

ASH and soot can be readily removed from the radiator of a warm-air furnace by the use of a child's sand pail and a vacuum cleaner. The pail should be tapered and about 3" in diameter at the larger end. A tenpenny nail hole is punched in the center of the bottom of the pail and in the center of the handle so that a length of No. 14 wire can be inserted and looped as illustrated. The top of the pail is squeezed to a slightly oval shape having the handle across the small diameter.

To operate this cleaning arrangement, tie the front clean-out door open and push a length of wire through to the check damper in the smoke pipe. Then fasten a rope to the handle of the bucket and to the wire, and a rope to the wire loop in the bottom of the bucket. Push the edge of the bucket down into the dust and pull it and one length of rope to the clean-out door. Remove the wire and repeat the operation several times with the ropes and bucket. The use of the suction nozzle of a vacuum cleaner at the clean-out door will avoid spilling the accumulation of dust into the basement.—ALFRED D. SLATER.

Lawn-Mower Grass Catcher Made from an Old Bushel Basket



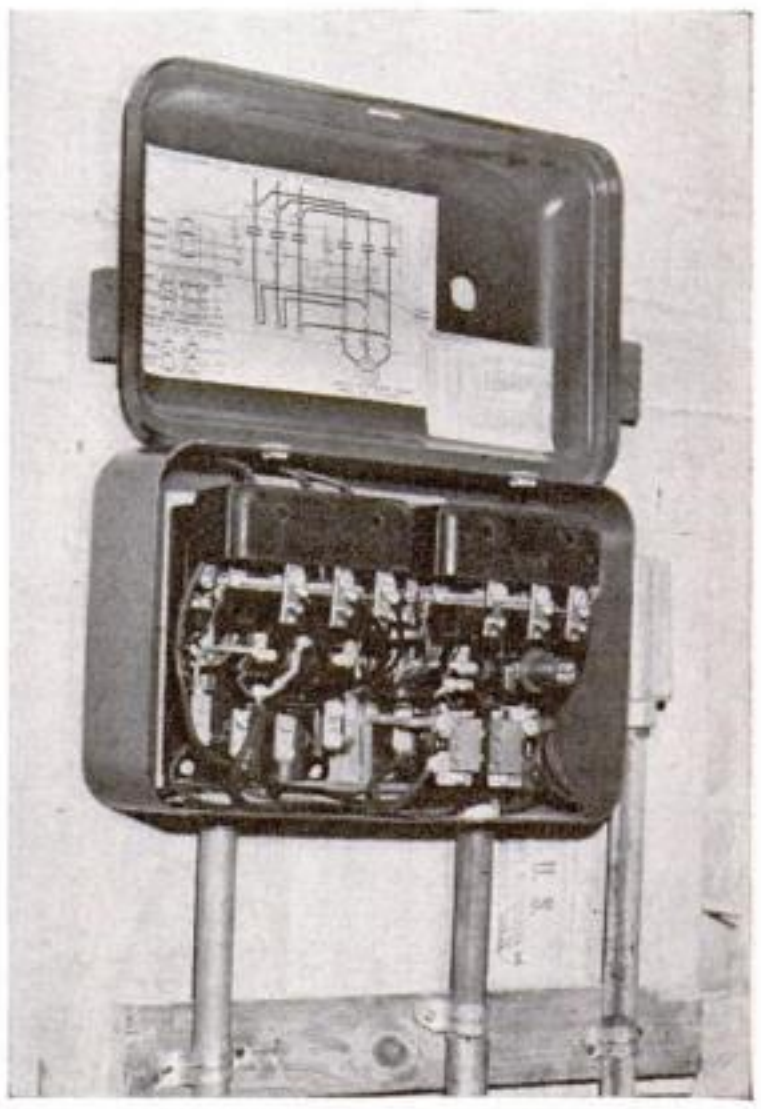
Keeping a lawn in good appearance entails constant attention and considerable labor. A large portion of this is avoided by mowing with a grass catcher

MANY gardeners leave lawn clippings where they fall to add to soil fertility, but those who prefer to use a grass catcher can make a good one out of a bushel basket. Cut the basket so that one part is slightly the larger, with a handle at its middle. Nail a cleat across under the cut edge. Staple a semicircular-shaped No. 8 wire about 1" from the bottom, bending the ends outward to engage the mower clips. Secure the handle of the basket to the lawn-mower handle by means of a coil screen-door spring after applying a coat of green paint.—B. N.

GETTING MOTORS OFF TO A

Push buttons (arrow) on the manual starter at left act mechanically to operate heavy-duty toggle mechanism. The unit has thermal overload relays

Shown below is a contactor of magnetic design. It is used on a conveyor for forward, reverse, and stop controls



How Special Control Devices Used on Machines in War Plants Guard Against the Burning Out of Costly Electrical Equipment

By HAROLD P. STRAND

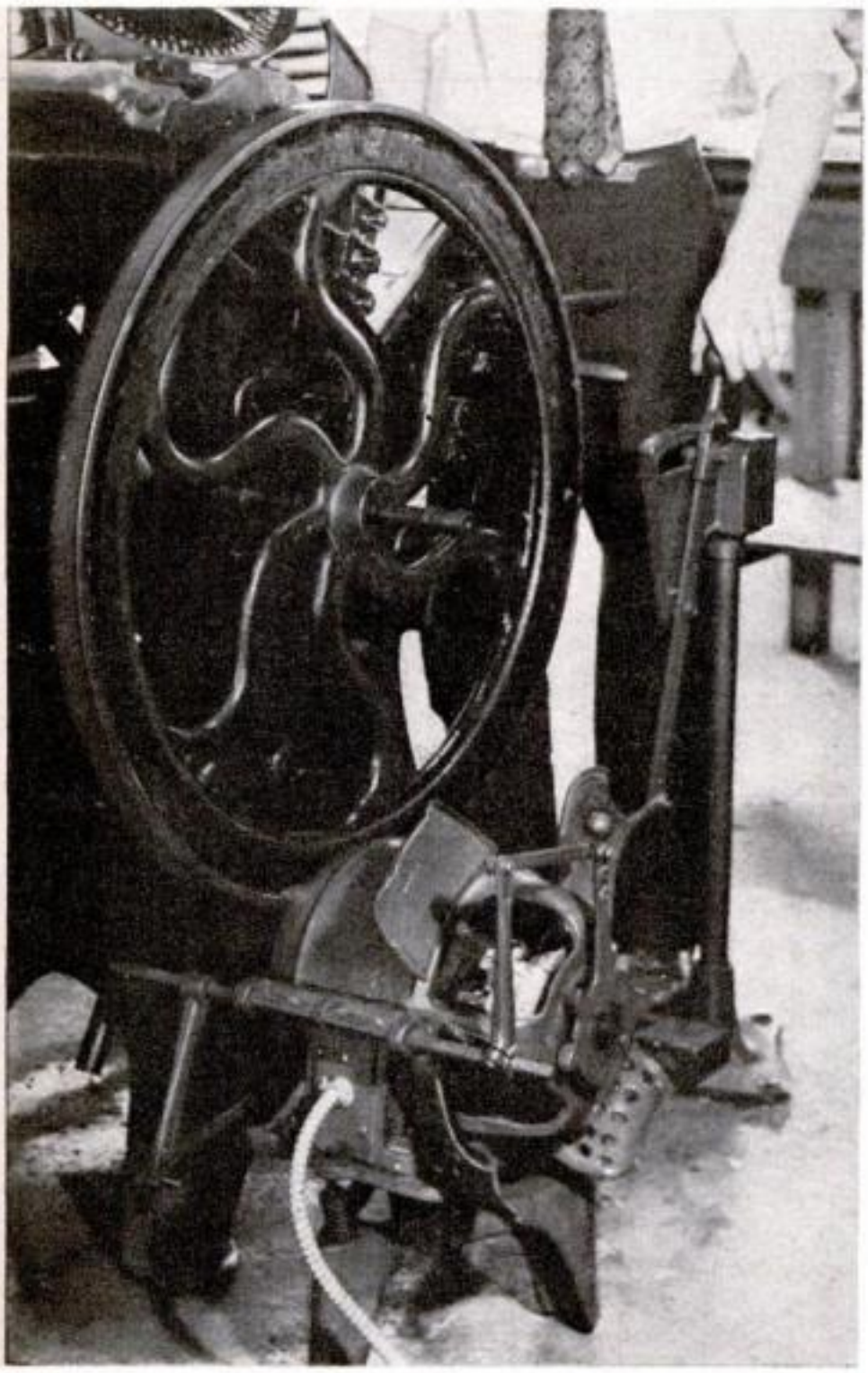
STARTING controls for motors in war plants are likely to puzzle the home-workshop mechanic who comes into contact with them for the first time. They are encountered in a variety of designs, each serving the special need of the motor it controls. But their primary purpose is to overcome electrical overload and inertia when a motor is started.

Looking at them, the home-workshop owner may well wonder why a simple toggle switch suffices for the motor in his basement. The answer is that his fractional-horsepower motor uses so little current that elaborate switching is unnecessary.

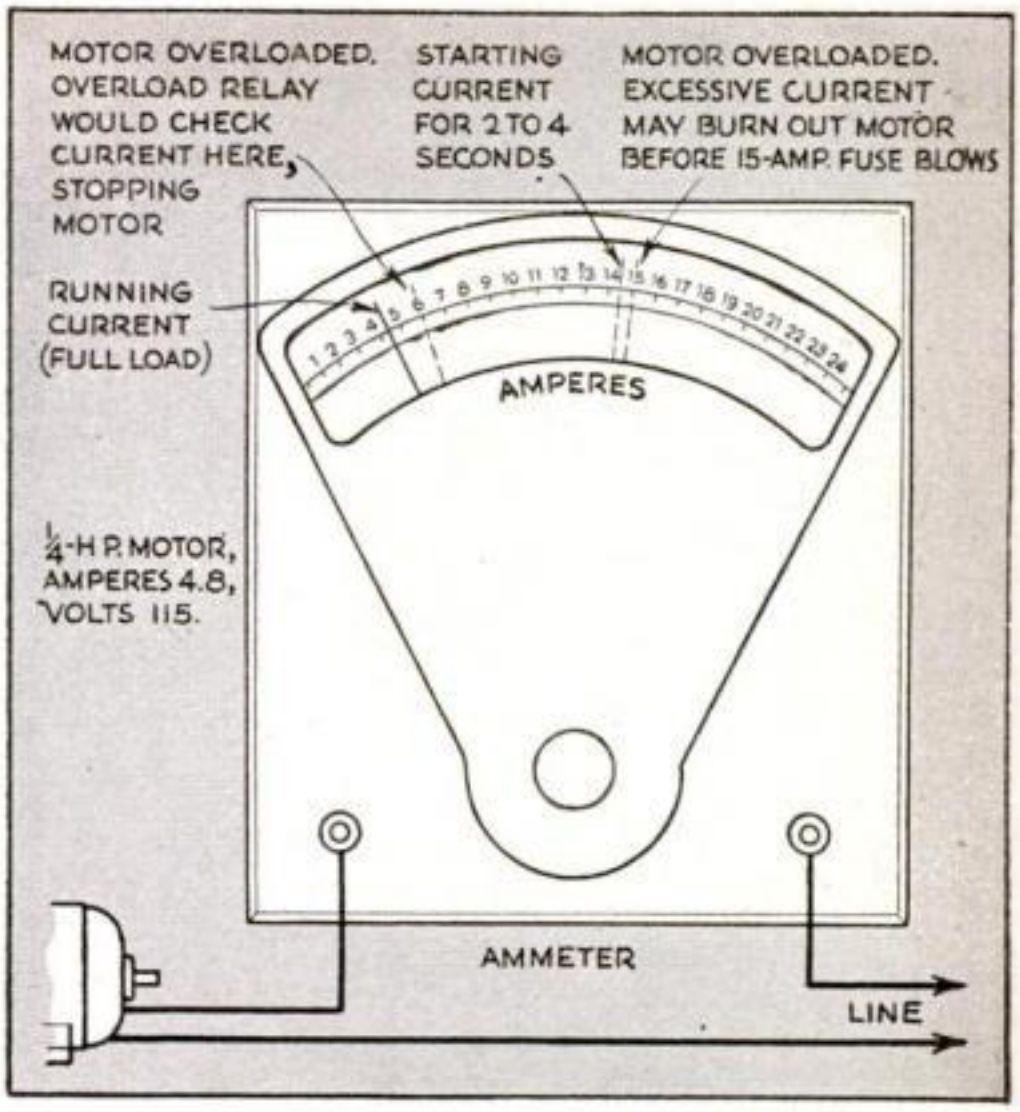
There are some precautions that should be taken, however, even with small motors. The rating in amperes of each switch used should be high enough to carry the starting current without overheating—generally twice that of the running current, or a 10-amp. switch for a ¼-hp. motor taking about 4.8 amps. If 220-volt current is available, and the motor is designed to run on either that or 110 volts, the higher voltage will cut amperage in half and cause less light "dip" when the motor is started.

Polarity plugs and receptacles are safeguards for portable units having controls on the machine or in the cord. They can be plugged in but one way, and connections can be made so that the switch always opens the

GOOD START



This printing press has a repulsion single-phase motor that can be adjusted from 500 to 2,000 r.p.m. as the hand lever alters the position of the brushes. A toggle switch controls the motor



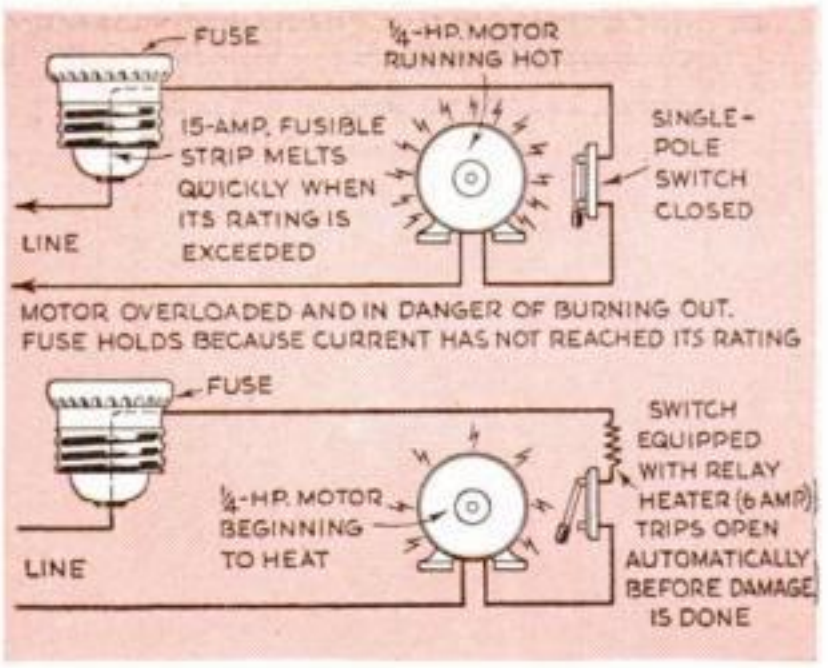
Differences in running, starting, and overload current are illustrated by the ammeter readings

live side of the line. Some overload protection besides fuses, which are essentially short-circuit guards, should also be provided. Time-lag fuses give this protection to a certain extent. They contain thermal elements that will allow temporary overloading for the starting current. Better still is a small circuit breaker connected in each motor line, or a toggle switch with a built-in thermostatic overload relay, which permits momentary overload, but trips off the switch if the extra load continues.

The drawing at the top of this page shows the great difference in running current, starting current, and overload current, using as an example a ¼-hp. motor taking 4.8 amps. While the ammeter needle is at only 4.8 amps. when the motor is running under full load, it registers 14.4 amps., or 300 times as much, for two to four seconds during starting. The overload relay has been set to stop the motor at 6 amps., an overload of 25 percent, which is the maximum that should be permitted, and then only for short periods. Without this control, the motor might burn out before a 15-amp. fuse could blow.

This is particularly important for large motors. In the case of a 15-hp. three-phase 220-volt motor taking 38 amps. running current, for instance, the 300 to 500 times as much current it takes in starting would be tremendous. For this reason, one of the standard motor starters is usually selected for motors above 2 hp. These rugged controls may be either manual or magnetic in action. Manual starters are the cheaper and are satisfactory for motors rated as high as 5 hp. single phase and 7½ hp. polyphase at 550 volts. They have thermal overload relays, and their wire connections are simple. One starter of this type is shown in a photograph on the facing page. It has push buttons, but these are entirely mechanical in action, operating a heavy-duty toggle mechanism.

Ratings for magnetic starters run up to 50 hp. and more. The main unit is a contactor operated by the magnetic action of a coil. Push-button stations control the current through the coil, and these may be placed in the switch cover, under it, or any-



Some overload protection besides a fuse is needed on any motor, large or small. One safeguard is a thermostatic relay switch

At the left is a push-button station placed near a conveyor to provide instant control

where desired for local or remote control. If voltage drops sharply or power shuts off temporarily, the switch opens automatically, stopping the motor, and the operator must press the starter button to start it again. These starters are also equipped with overload relays which, added to undervoltage release, make them "tops" in controls.

The main contactor of a magnetic starter used with a floor-to-floor conveyor is shown in a photo on page HW 178. It is of the reversing type with twin contactors and has a stop and reset button in the face. Push-button stations for instant control are placed handy to the conveyor on each floor. One is shown in the photo on this page.

In some cities and towns, the power company or municipal authorities may not allow the starting of motors above 7½ hp. with across-the-line starters. This is because of line fluctuations and possible damage to power equipment caused by heavy starting current. In these places some form of reduced-voltage starting control, such as a primary-resistor or autotransformer starter, is necessary.

The former has a series resistance that permits 65 percent of the line voltage at starting. As the motor gathers speed, this is gradually cut out automatically until full voltage is applied. Some varieties are also used to provide a smoother start for machinery that, because of its construction, may be injured by the sudden application of full voltage. Ratings for reduced-voltage controls may run from 5 hp. to 30 hp. or more.

Autotransformer starters, commonly known as starting compensators, are useful for motors driving heavy loads, such as pumps, compressors, blowers, and similar directly connected machinery. They have contacts operating in a bath of special oil that minimizes flashing. Taps are available on the transformer to permit a selection of starting voltage best suited to the load. Ratings often run as high as 150 hp. at 550 volts and several hundred horsepower at 2,200 volts. These starters have both overload and undervoltage protection.

There are a great number of other kinds of starting and controlling equipment, including many types of D.C. controllers, pressure and temperature switches, drum controllers, limit switches, solenoid valves, and photoelectric relays. Each has its special purpose for some type of motor. Of most interest are the speed controls as applied to A.C. motors.

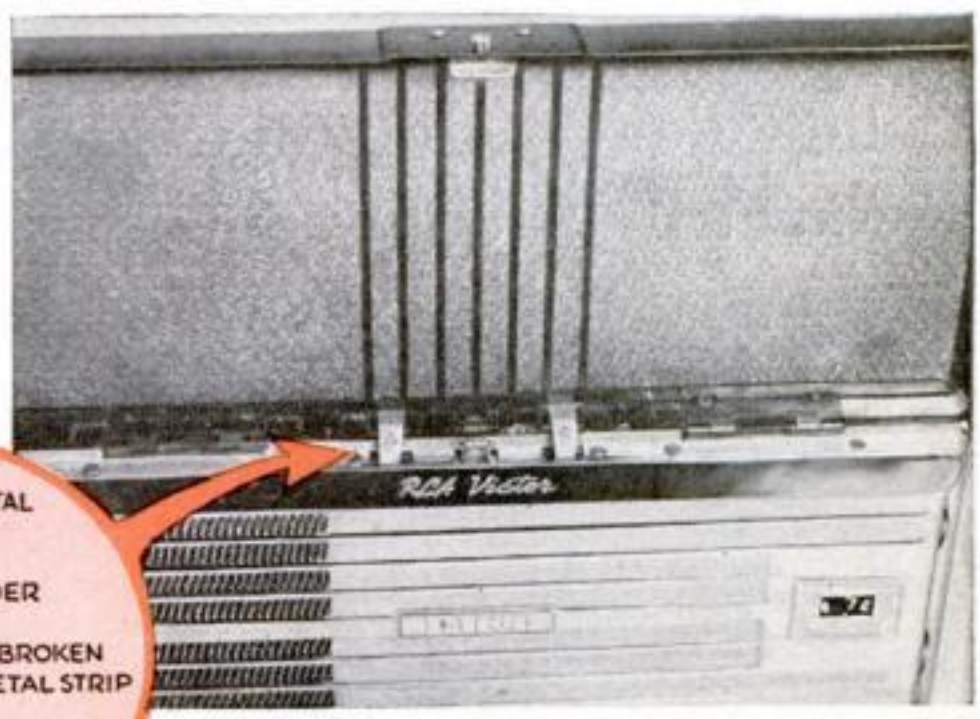
Some forms of capacitor motors used on single phase are adaptable to limited-speed variations. Printing presses often use a repulsion single-phase motor, which can be adjusted from 500 to 2,000 r.p.m. by changing the position of the brushes. This is done by a hand lever, as shown in the photograph on the preceding page. A small toggle switch on the front of the stand controls the motor.

Polyphase motors are built in several types for variable speed, the most popular being probably the slip-ring wound rotor. In this design the armature has a winding, the ends of which are brought out to slip rings upon which the brushes bear. When a variable resistance with a special triplex rheostat is provided in the armature circuit, the speed can be reduced to 50 percent. There are also multispeed motors for polyphase that give two, three, or four fixed speeds.

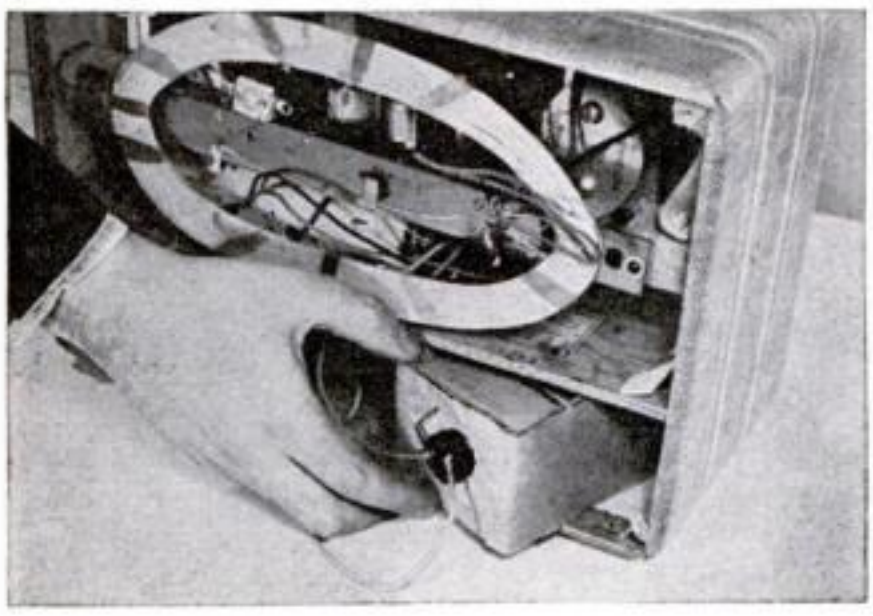
Servicing Your Radio

TESTS ON BATTERIES from a portable receiver should always be made with a voltmeter—it is the only testing instrument that will show accurately the effective voltage of a battery. It is risky business to use any other device, including a flashlight bulb or an ammeter, since many of them are likely to affect the life of a battery materially. An ammeter —especially bad to use for this purpose— has a low resistance and will short a battery when placed across it. Invariably it will also give a high reading even when a battery is badly run down.

STRIPS CONNECTING THE LOOP ANTENNA inside the cover of some midget portable receivers are likely to wear and break off near the hinge as a result of frequent opening and closing of the lid. When such a break occurs, reception stops. These metal strips can be repaired, however, with short lengths of twisted metal cord like that used in repairing radio dials. Remove the broken part of the original metal strips at their connection with the two wires inside the set; then solder one end of the cord to each of these wires, and solder the other end to that portion of the strips connected to the antenna.

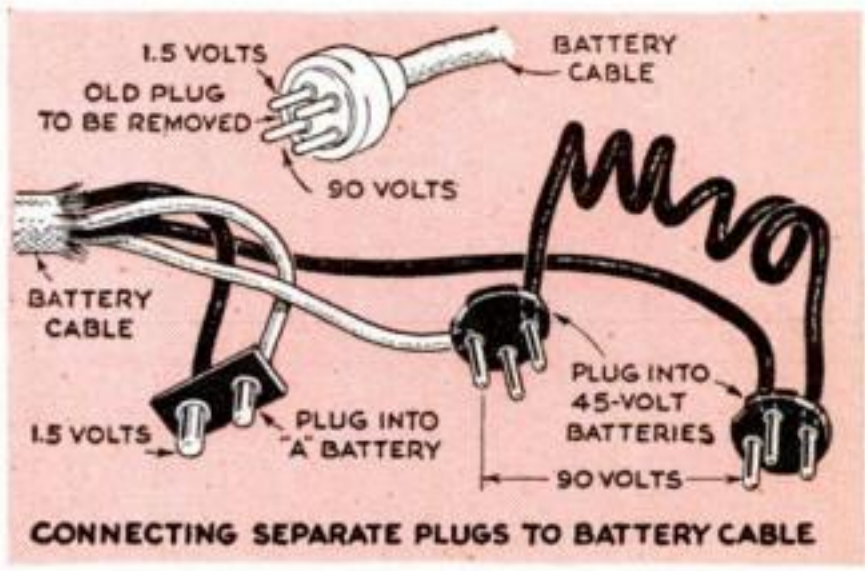


Where a loop-antenna connection is likely to break. Repair it as shown at the left



THREE SEPARATE PLUGS can be substituted for a single battery-pack plug, as shown in the drawing below, to permit use of separate "A" and "B" batteries with a portable if a battery pack cannot be obtained. In removing any plug from a battery, always grasp the plug itself. Never tug on the wire, for this may pull the insulation back, and a short caused by wires touching can render a battery useless in 15 minutes.

BATTERIES THAT DO NOT FIT TIGHTLY in their compartment will not knock about if wrapped in corrugated cardboard. A round hole cut in one piece of the material will permit insertion of the battery plug. To conserve your battery, turn off the receiver when it is not in actual use. If you have a three-way set, use electric current when possible. Batteries kept outside the case at 60-deg. temperature may last 18 months.

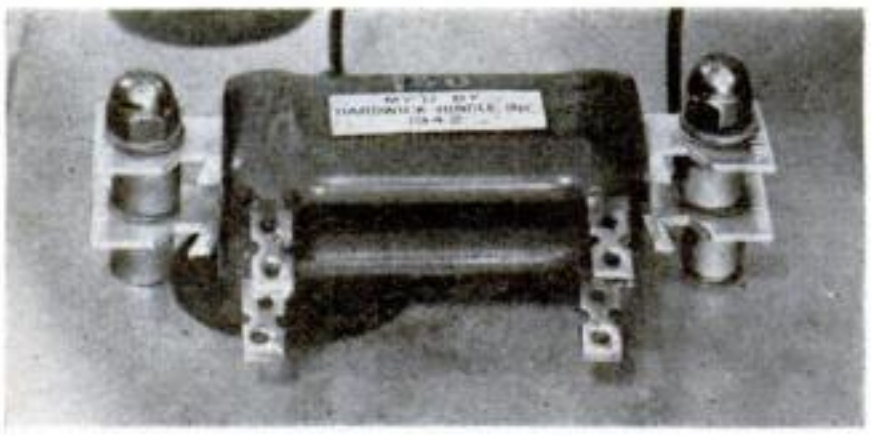


CONNECTING SEPARATE PLUGS TO BATTERY CABLE

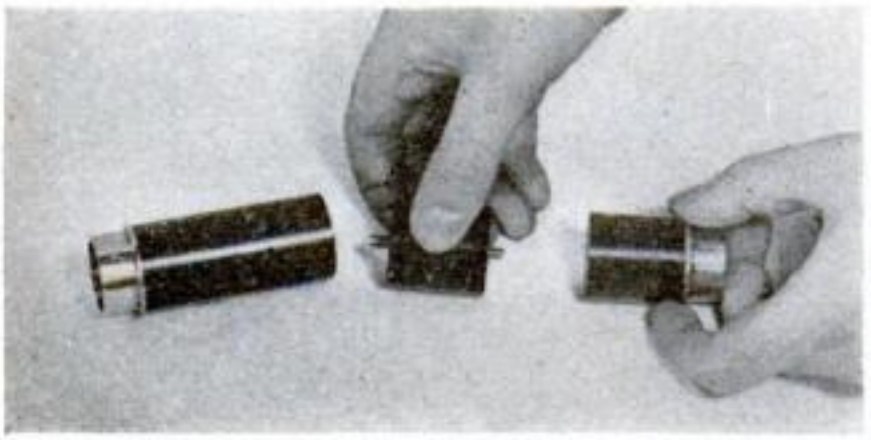
Radio Ideas

AN ULTRAHIGH-FREQUENCY portable transmitter and receiver is said to provide two-way communication over distances of 5 to 30 miles, and to meet requirements for Civilian Defense service. It is powered entirely by self-contained dry batteries. A simple switch enables the user to change from transmitting to receiving operation instantly. The circuit employed makes possible the use of either a carbon or a crystal microphone. A vertical antenna rod telescopes into the cabinet when not in use.

PISTOL-GRIP SOLDERING IRON. The soldering tip of this iron consists of a loop of ⅛" copper wire shunted across the secondary terminal of a low-voltage transformer drawing about 80 watts from 110-volt A.C. lines. A trigger switch controls the primary current. The iron is unusually easy to handle. It reaches soldering temperature in 5 seconds, cooling again upon release of the switch, so that oxidation of the tip is minimized.

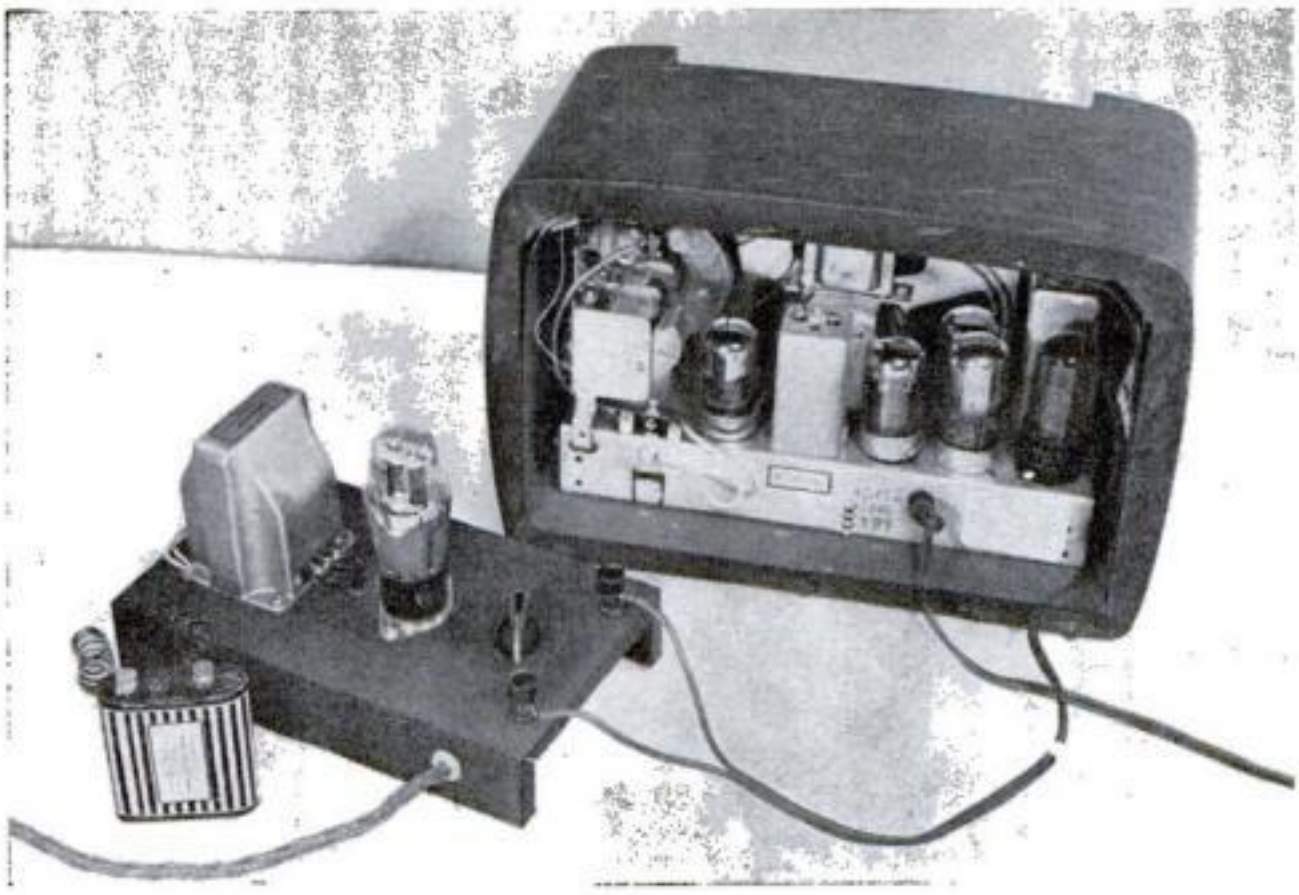


FLAT-TYPE RESISTORS mark a departure from the conventional tubular type, offering a higher wattage per unit of space required, substantial reduction in depth behind the mounting surface, ease in mounting singly or in stacks, lower inductance, and light weight. Both resistor and mounting are an integral unit, and cannot rotate or become loose. The connecting terminals are of the standard type.



SECTIONAL RESISTORS are available in units that can be used singly or in combination for any desired resistance value. Individual sections consist of resistance wire wound noninductively on ceramic spools and adjusted to a rated current of 1 milliampere. Standard values range from .25 to 1 megohm. The units are locked together both mechanically and electrically with a small stud, and can be separated at will.

Suppressor Built from Junked Parts Reduces Man-Made Static



by
ARTHUR C.
MILLER

Left, the unit connected to a midget A.C.-D.C. radio. It may be used with almost any receiver

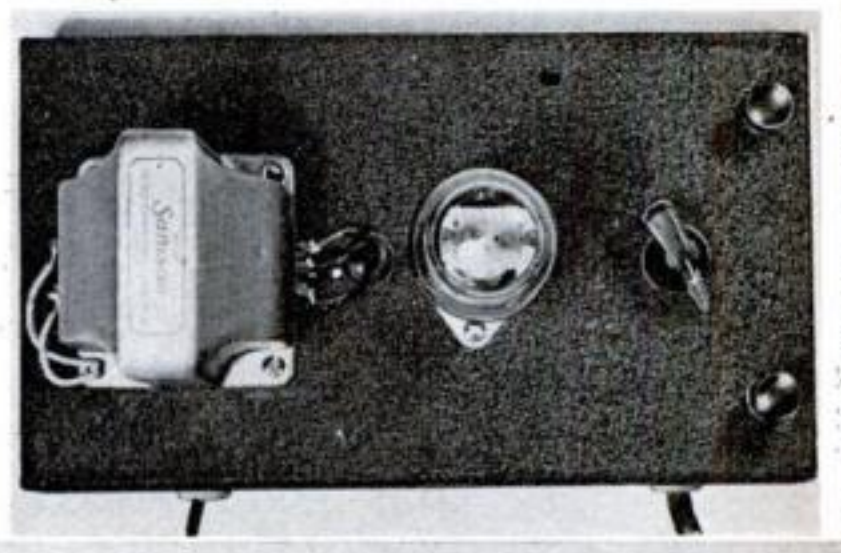
A top view of the unit is shown in the first photo below. Few connections are necessary, as can be seen in second photo. Drawing shows how the static suppressor is hooked up to a receiver

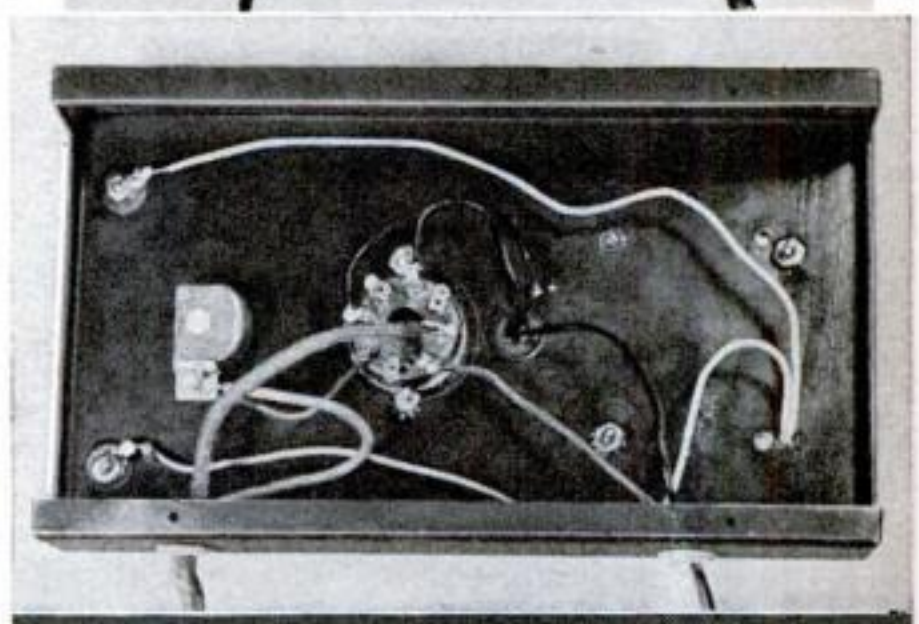
OWNERS of sets ranging all the way from headphone "one-lungers" to 12-tube console models may find good use for this static suppressor. Easily attached across the output circuit, it will in most cases reduce severe man-made static by at least 50 percent. There is a slight loss of volume, but this can be overcome by turning the volume control.

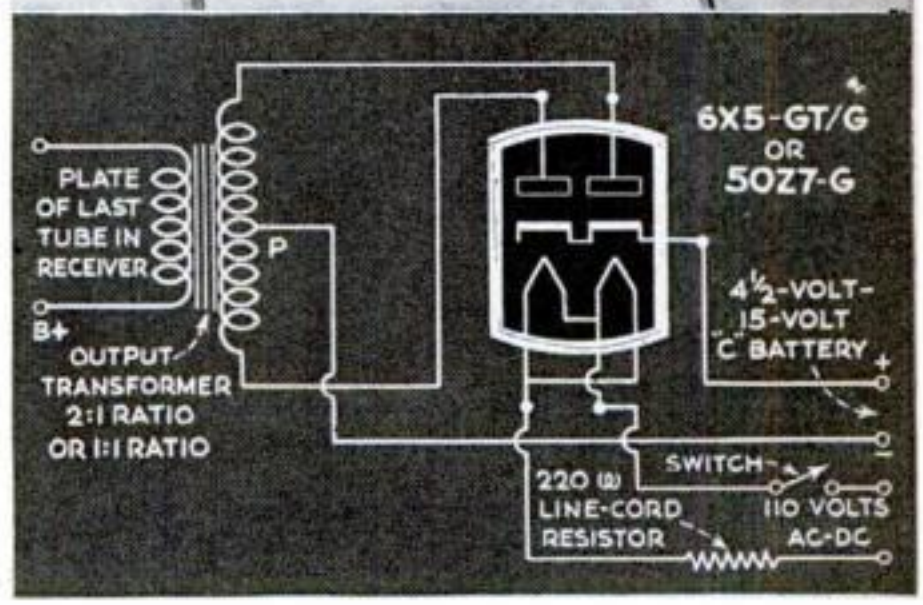
The unit comprises a full-wave rectifier tube (such as the 6X5-GT/G or 50Z7-G), a push-pull output transformer, a 220-ohm line-cord resistor, a S.P.S.T. toggle or rotary switch, and a 4½-volt "C" battery. The secondary of the output transformer must have a high resistance. One of the old output transformers used with magnetic speakers will do admirably, and may be retrieved from the junk box. A class "B" interstage transformer might be tried, but make sure that the primary winding passes enough current. It is useless to attempt to use a transformer with an 8-ohm secondary.

Any kind of chassis, wood or metal, may be employed. The transformer, eight-prong tube socket, and switch are mounted on the top of the chassis. Drill ½" holes in the back for the line cord and the two leads to the "C" battery. The secondary leads of the output transformer (primary side if it is a class "B" interstage transformer) are connected to two plastic binding posts, which provide connections to the set.

Remove the radio chassis from the cabinet. Use leads not longer than 3' or 4' to make connections to the plate of the last tube and the B+ lead. Do not alter speaker connections.



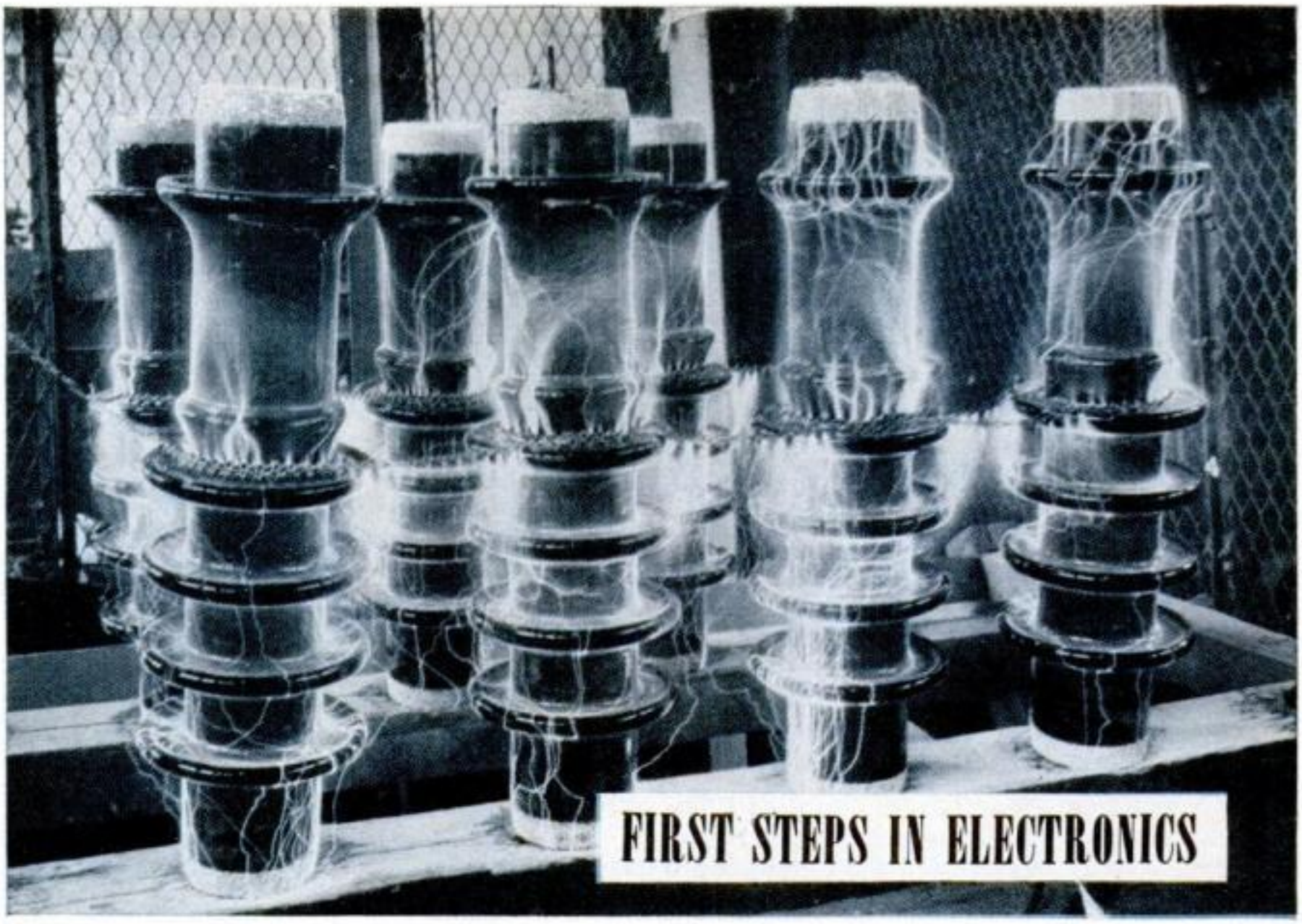




LIST OF PARTS

- Chassis, metal or wood
- Full-wave rectifier tube 6X5-GT/G or 50Z7-G
- Eight-prong octal wafer socket
- Output transformer (see text)
- Small "C" battery, 4½ volts
- Line-cord resistor, 220 ohms
- Binding posts (2)
- Rotary or toggle switch, S.P.S.T.

HW 183



How Electrons Are Controlled

By CHARLES I. HELLMAN

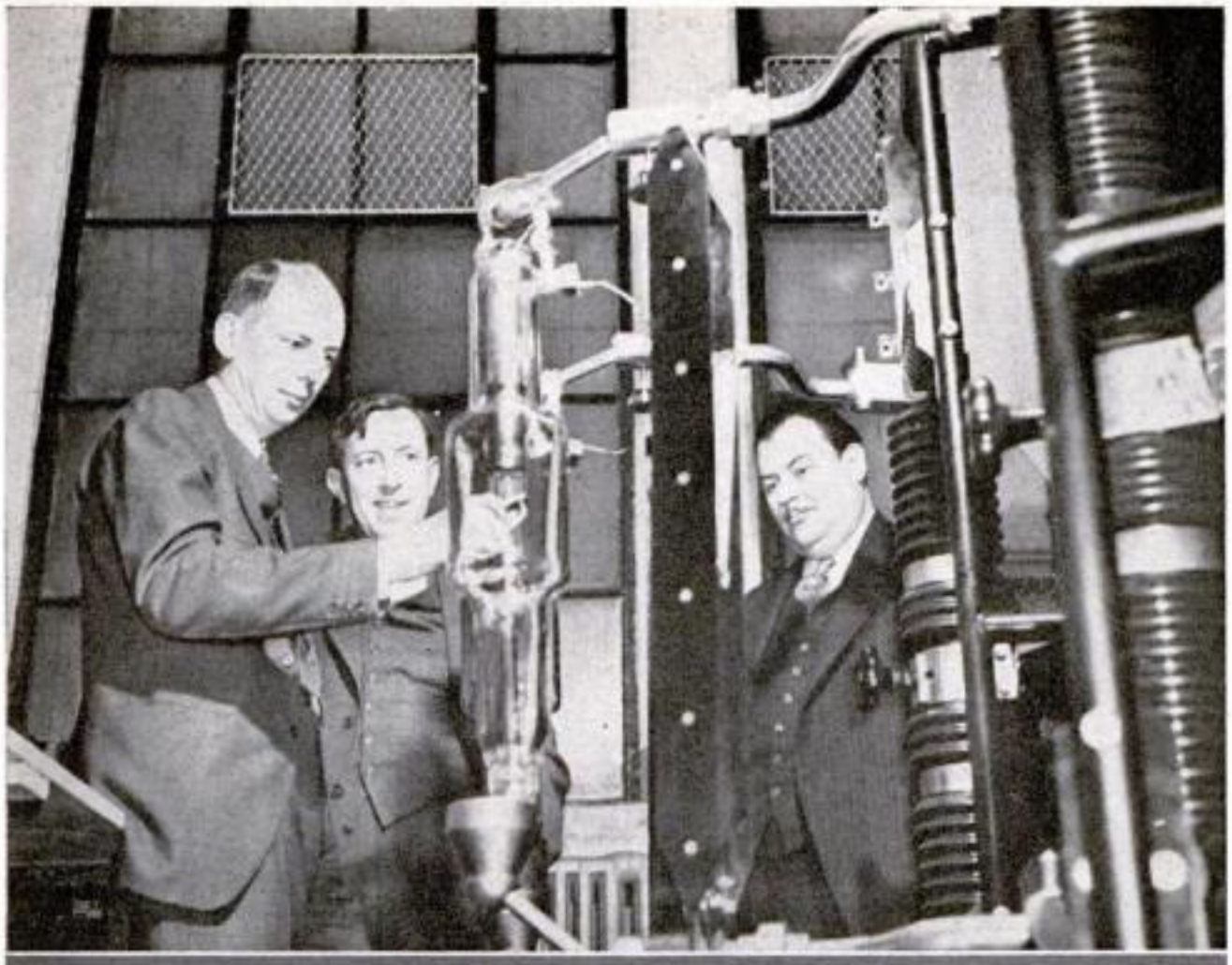
BY FAR the tiniest particle yet put to work by man is the electron. With this mighty midget, science has wrought miracles as divergent as measuring the infinitesimal amount of light reaching the earth from a distant star and smashing an atom with force like that of a thunderbolt. Wartime research has so speeded the coming of the age of electronics that these minute particles of electricity are now used in X-raying high-speed bullets as they crash through armor, in killing germs, in heating molded airplane parts, in locating enemy airplanes, and in controlling machinery.

Electrons may be freed in several ways. In the vacuum tube they are evaporated from a hot filament; light falling on the sensitive metal in the photoelectric cell ejects electrons; and high-speed electrons striking a target may knock out secondary electrons of different energy levels.

One of the basic problems of electronics now being solved is the control of these electrons. It is through this control that the light of the distant star is measured and the atom smashed. In this article we shall demonstrate electron control by simple experiments which anyone can do at home, and then show a few of the applications of this control to today's problems.

First, it may be well to review briefly our knowledge of electrons, which can be stated simply in the electron theory of matter—the theory that all matter is made of electrical charges. According to this theory, infinitesimal, charged particles of electricity called electrons rotate around the nucleus of an atom to make up a miniature planetary system. The atom is the smallest division of matter that still has the chemical properties of an element. As long as it holds electrons in its orbit, these electrons cannot be put to work. The negative charge of the electrons is balanced by the positive charge of the nucleus.

To collect electrons, energy is necessary to pull them from the attracting force of the nucleus. This is demonstrated in the well-known experiment of the hard-rubber comb run through the hair. Some electrons are removed from the hair and added to the rubber, the excess giving the comb a negative charge. Their presence can be detected when a finger is brought near the charged comb, attracting a stream of electrons that gives off a crackling sound.



Giant insulators undergo high-voltage torture in photo at left. Cascades of sparks show they have reached the breakdown point in this strenuous test. Above, 300,000-volt high-speed X-ray tube with which millionth-of-a-second X-ray pictures can be taken through one inch of steel armor plate

Bring the negatively charged comb near some bits of paper, and it will pick up or attract the paper. Bring it or a negatively charged rubber rod near the top of a stream of water flowing gently from a tap, and the water will swing far over to the charged rubber, as shown in two photos on the next page. These experiments prove that *charged bodies attract neutral bodies.*

Now, to show the opposite effect, push a thread through a grain of puffed breakfast cereal, hold it so that the grain hangs free, and bring the charged comb near. The grain will be attracted to the comb at first, but the instant it touches the comb, it will be repelled violently. The charged comb gives the grain some of its excess electrons, imparting to it a negative charge like its own. That the grain is repelled after both it and the comb are negatively charged demonstrates that *like charges repel.*

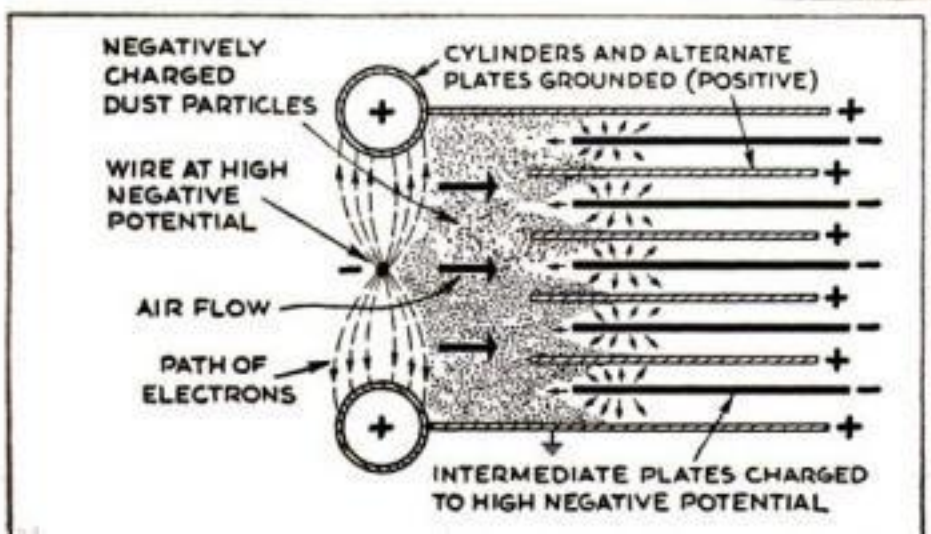
Suspend the rubber comb from a thread so that it balances, and charge it negatively by running it through the hair. Then charge a glass rod positively (a stirring rod or towel rod will serve) by rubbing it on a piece of silk, which robs it of some of its electrons, charging it positively. If you bring the glass rod near the comb, the latter will swing toward it, *because unlike charges attract.*

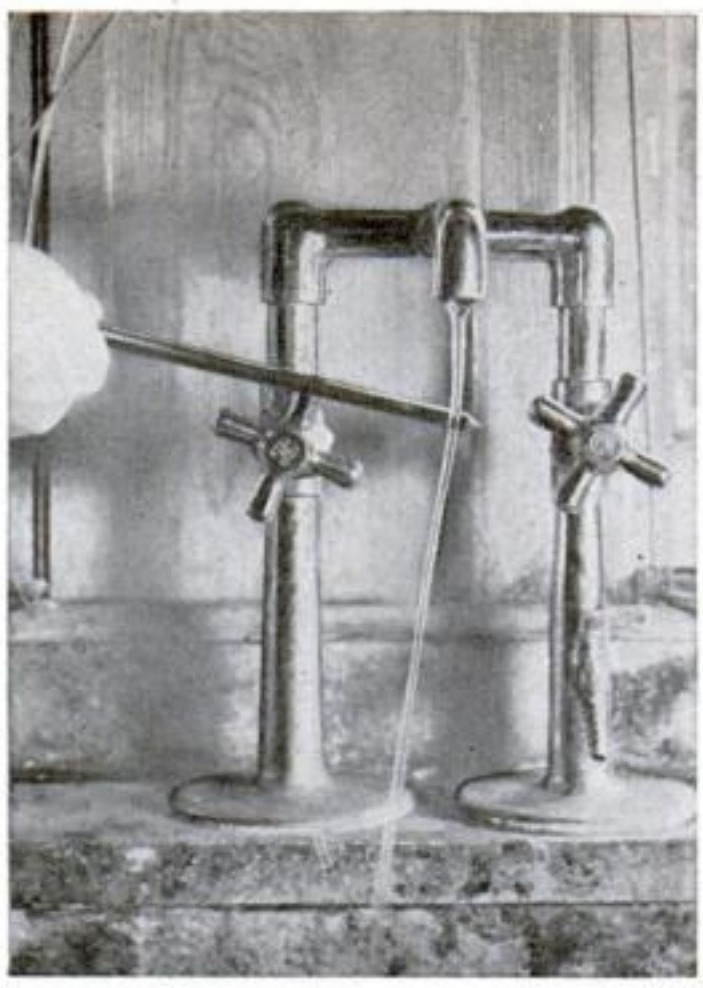
One application of electrons in industry can be demonstrated with two strips of newspaper about ½" wide and 20" long. Hold the two strips vertically by the top, and stroke each separately by running the fingers down the length. The strips, which originally hung straight down, now spread apart, as illustrated in an accompanying photograph. Since each strip was given the same charge by friction, they repel each other.

This principle is used in the electroscope, a device for detecting the presence of electrical charges and for determining whether they are positive or negative. Thin strips of metal foil are used in place of the paper.

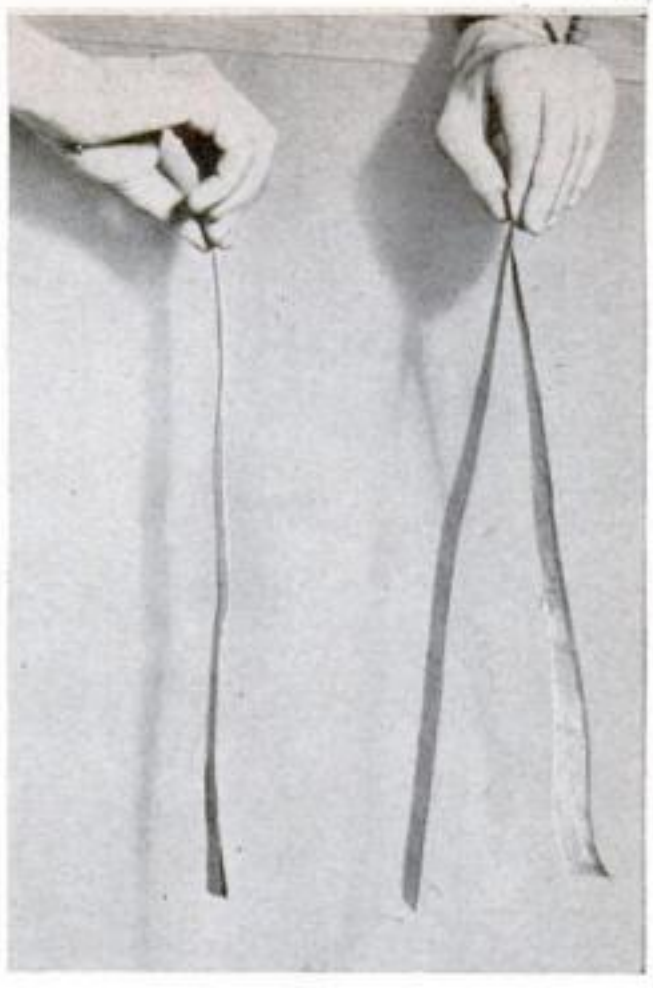
Thus, through the principles demonstrated in these experiments, we come to the fundamental law of electrical charges: *Like charges repel, unlike charges attract.* Properly used, this knowledge offers such vast

The drawing below explains the principle of the precipitron. The heavy arrows point out the paths of dust-laden air. At the right, plates of a precipitron as used in an industrial plant





A stream of water flowing gently from a tap, at left above, can be made to swerve from its normal course if a negatively charged rubber rod is held near the top of the stream. This simple experiment shows how electrically charged bodies attract neutral bodies



When two newspaper strips are stroked downward, they spread apart as above, showing how like charges repel each other

possibilities in controlling electrons that it may well be likened to an enchanted wand. If we want the electron to move upward, it is only necessary to bring a positive charge over it. We may now increase the electrostatic force by placing a negative charge below the electron, thus repelling it from below as it is attracted from above.

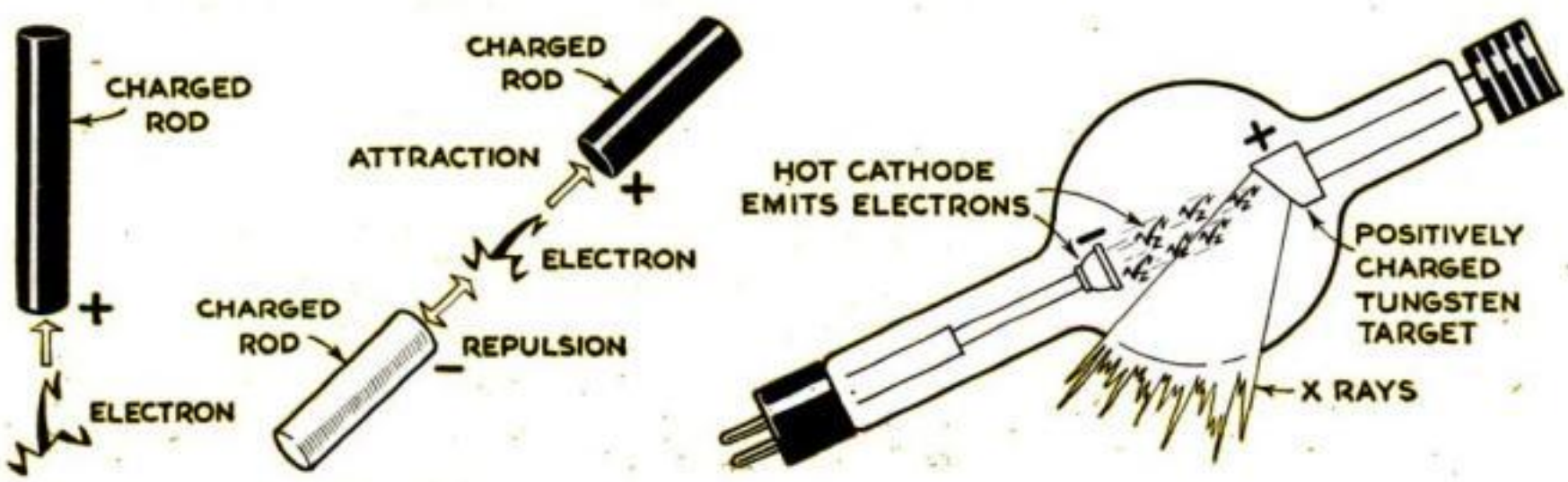
This powerful electrostatic wand has many important military and industrial applications, among them the production of X rays. One of the drawings shows the construction of an X-ray tube. Electrons evaporated from the hot cathode come under the tremendous pull of the tungsten anode, which has a positive charge of hundreds of thousands of volts. As a result, the electrons are accelerated and strike the tungsten target with a terrific impact, giving up their energy to the tungsten, which in turn radiates what we know as X rays.

Another ingenious electronic device guards many of our war industries from the sabotage of dust. This is the precipitron, shown in both a photograph and a diagram on page HW 185. It contains a series of plates charged with positive and negative electricity. A wire at a high negative potential gives off electrons in the path of a flow of air, and they impart a negative charge to dust and other foreign particles in the air. These negatively charged particles are repelled by the negative plates in the precipitron as they pass and are attracted and held by the positive plates.

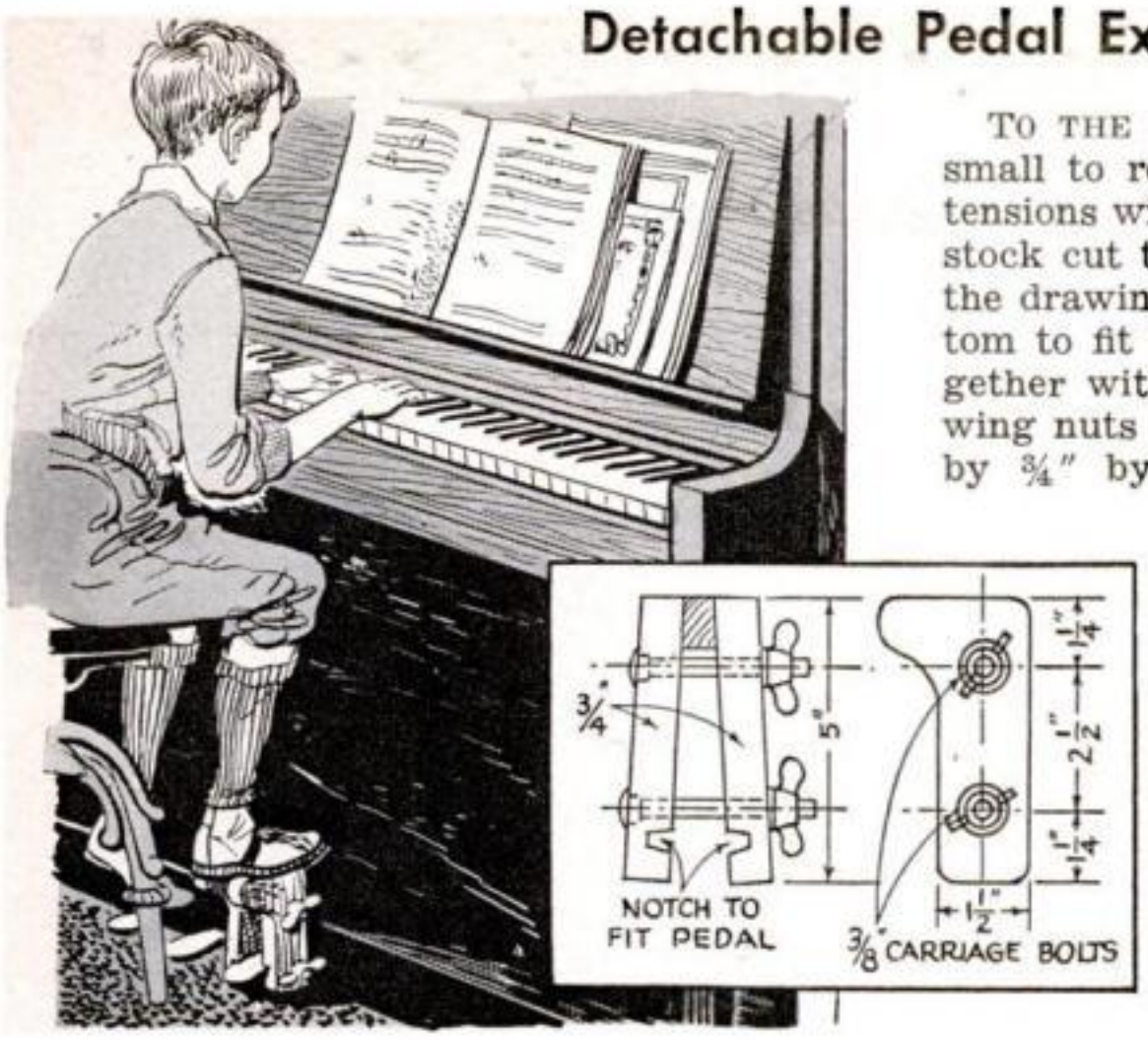
Installed in the ventilating system of a film-manufacturing plant, this precipitron eliminates dust that might ruin the film. The same principle has been applied to precipitate soot from smoke in chimneys.

A positive charge placed near an electron will attract it. A negative charge placed on the side opposite accelerates the electron by repelling it at the same time the other charge attracts it

Below, an X-ray tube. The electrodes come under the pull of the positive tungsten anode, striking it with a terrific impact, the energy of which gives rise to the emission of powerful X rays



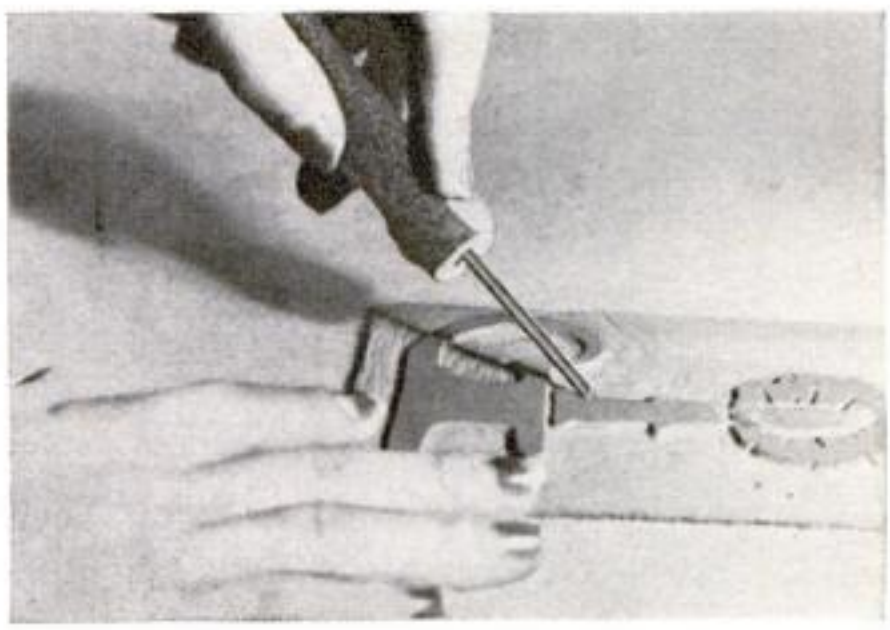
Detachable Pedal Extension for Child's Use



TO THE young musician who is still too small to reach the piano pedals, these extensions will prove a great help. Out of ¾" stock cut two pieces to the shape shown in the drawing. These are notched at the bottom to fit the piano pedal and fastened together with two ⅜" carriage bolts having wing nuts and washers. Glue or nail a ½" by ¾" by 2¼" filler strip along the top edge of one piece before assembly. This makes the tread wide enough at the top to accommodate a child's foot naturally. The height of the extension shown is 5", but this can be varied according to the size of the child. Finish the extensions to harmonize with the piano, preferably before assembling so that parts will not stick.—AXEL E. OGREN.

Linoleum-Block Cutting Tool

AN UMBRELLA rib, fitted into a handle, will serve as an efficient tool for carving linoleum blocks. Drive a rib about 4" long into a small hole in a handle shaped from a dowel. Spread or close the groove of the rib with pliers to form a V-shape for fine line work or a horseshoe shape for ordinary cutting. File the cutting end sharp; then harden by heating to a dull red and plunging in cold water. A curved cutting edge in the form of a crescent is best for scooping out large areas.—NATHAN A. GAINEN.



SMALL-DIAMETER CONDUIT WIRES [*ELECTRICAL*]

IN BUILDINGS originally wired with conduit or tubing, rewiring is sometimes necessary to take care of additions and alterations. In such cases, the conduits may not be large enough to accommodate the additional number of wires. To meet such conditions, the National Electrical Code permits the use of special small-diameter wires that can be installed in the conduits in greater numbers than conventional Type R wires. The following tables give the approved specifications.

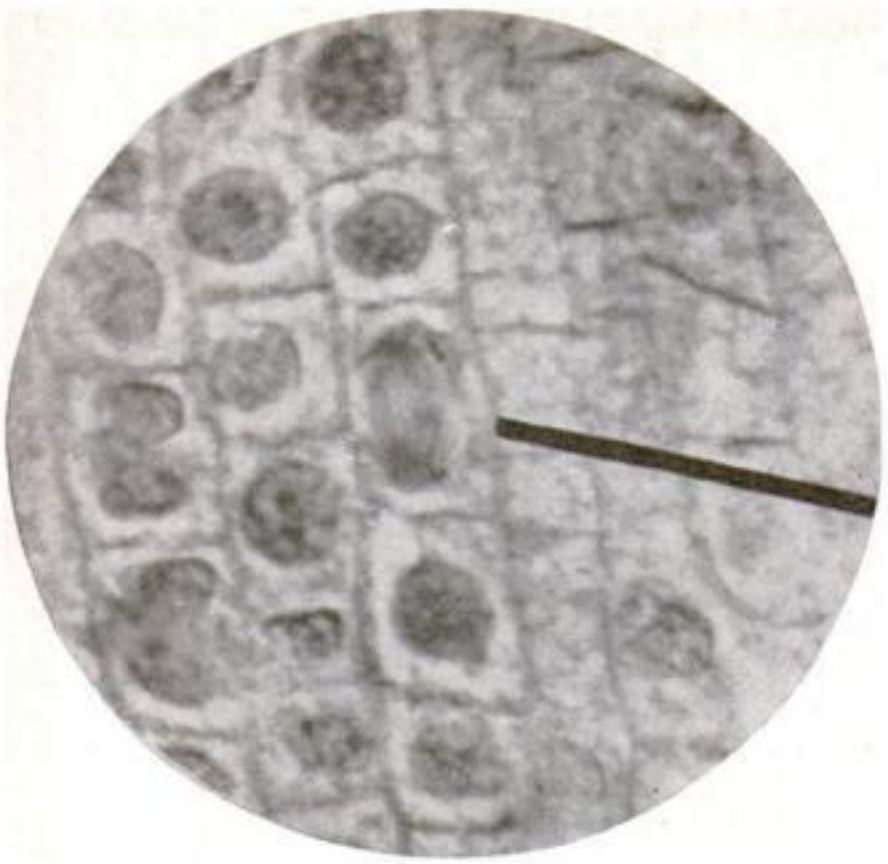
Types RHT and RPT
(up to 600 volts)

Size of conductor	Number of conductors in one conduit or tubing: 1	2	3	4	5	6	7	8	9
	Size of conduit or tubing								
14	½"	½"	½"	½"	½"	½"	½"	¾"	¾"
12	½"	½"	½"	½"	½"	¾"	¾"	¾"	¾"
10	½"	½"	½"	½"	¾"	¾"	¾"	¾"	1"
8	½"	½"	¾"	¾"	1"	1"	1"	1"	1¼"

Types SN and RU
(up to 600 volts)

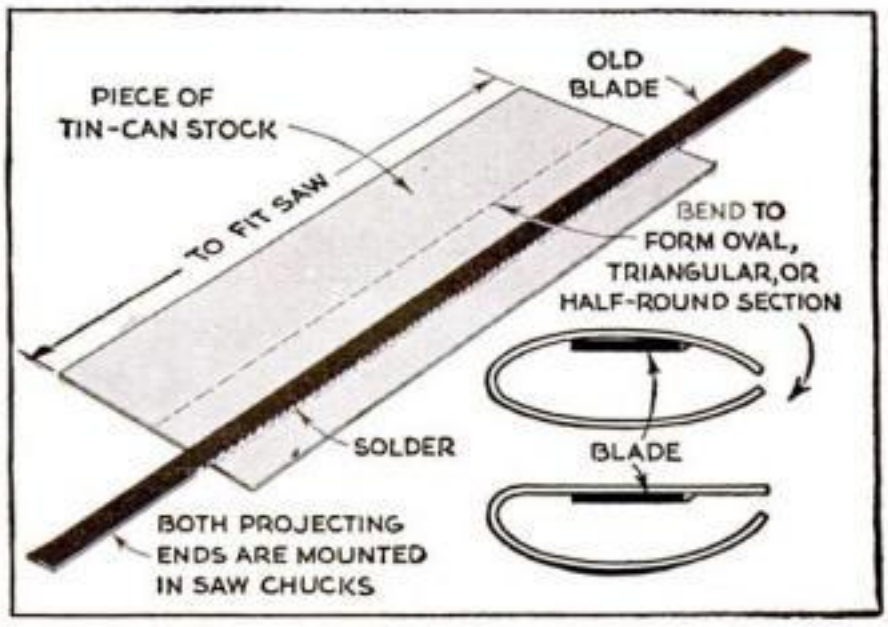
Size of conductor	Number of conductors in one conduit or tubing: 1	2	3	4	5	6	7	8	9
	Size of conduit or tubing								
14	½"	½"	½"	½"	½"	½"	½"	½"	½"
12	½"	½"	½"	½"	½"	½"	½"	½"	¾"
10	½"	½"	½"	½"	½"	½"	¾"	¾"	¾"
8	½"	½"	½"	¾"	¾"	¾"	1"	1"	1"
6	½"	¾"	¾"	1"	1"	1¼"	1¼"	1¼"	1¼"
5	½"	¾"	¾"	1"	1¼"	1¼"	1¼"	1¼"	1½"
4	½"	¾"	1"	1"	1¼"	1¼"	1¼"	1½"	1½"

POPULAR SCIENCE MONTHLY SHOP DATA

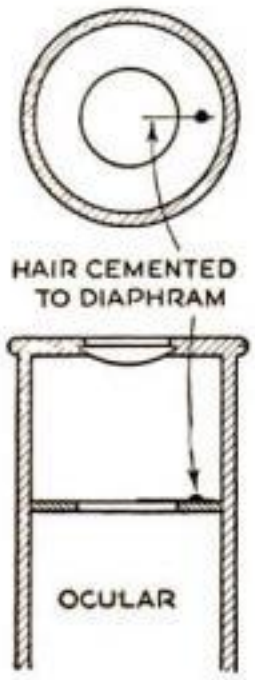


Abrasive Sleeve for Jig Saw Improvised from Old Blade

WHEN curved edges or cut-out work has to be sanded quickly, the job can be done on the jig saw, if no narrow-belt sander is available. Solder a piece of tin plate to an old jig-saw blade as shown below; then bend the piece over to form a half-round or oval section as indicated, making it small enough to pass through the saw-table opening freely. Apply adhesive tape over the metal as a soft backing, and stick on a folded strip of garnet paper with gasket cement or other adhesive. Despite the short stroke, garnet paper lasts a surprisingly long time, and when it is worn out at one end, the holder can be reversed in the saw chucks to bring the unused portion into play. Use the hold-down if the paper tends to lift the work off the jig-saw table during sanding.—H. W.



Microscope Eyepiece Pointer

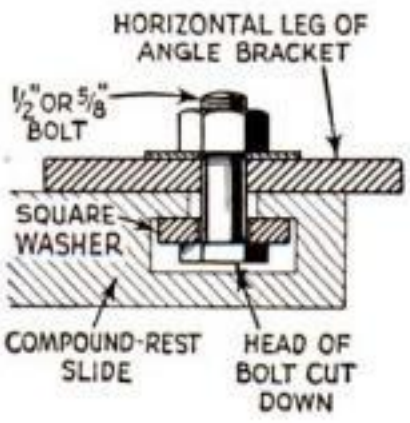


AN EYEPIECE pointer that can be used for indicating a specific area on a specimen as above is easily attached. Cut a straight black hair slightly longer than half the diameter of the ocular. Next, apply a drop of Canada balsam to the upper surface of the diaphragm. Place the hair in the cement, making sure it lies flat and points to the center of the aperture. Trim the hair just short of the center.—H. WHITTAKER.

Drill-Press Milling Attachment Used in the Lathe

SMALL milling attachments of the type especially designed for use on a drill press can be adapted to light milling and precision drilling in the lathe by means of simple angle brackets like that shown.

This bracket was made from a piece of scrap steel obtained from a junk yard. It is of ⅜" stock, is 7" long, and measures 3" on one face and 5" on the other. The holes were already in it to receive the ⅝" stud on the bottom of the attachment and a ½" or ⅝" bolt to lock it to the tool-post slot. The braces shown were cut from 1½" by ⅜" bar steel and arc-welded in place. The faces of the bracket were machined flat and to a right angle with each other after welding. This operation can be done on the lathe with the aid of an independent-jaw chuck. The sketch at left shows the angle piece bolted in place.



Irrigation before planting is important for dry soils. "Check up" your plot in 4' by 5' beds with borders 8" high. Fill each at least once from a sack-covered hose

How to Prepare the Soil and Seed Beds for a Bumper Harvest

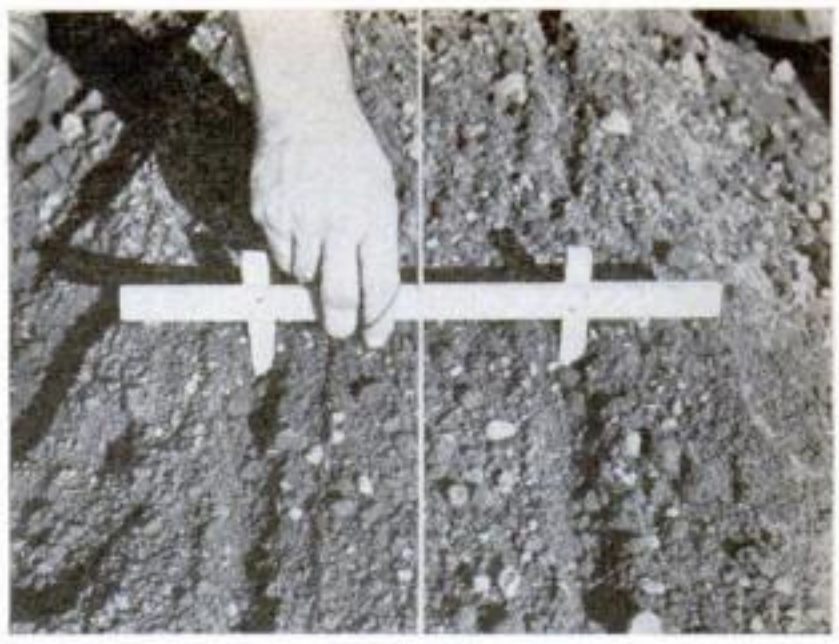
By ROSS H. GAST
Author of *Victory Edition, Vegetables in the California Garden*

UNCLE SAM wants you to garden—for victory! To show that he means it, his Department of Agriculture in Washington has set a goal for this summer of 18,000,000 victory gardens—12,000,000 on city, town, and suburban plots, and 6,000,000 on farms. This is more than three times the number planted in World War I to yield what was then a record harvest. It is time now for you to prepare to do your share.

You won't need many tools, but buy good ones. The only indispensable items are a long-handled shovel or spade, a hoe, a rake, and about 50′ of hose. A wheel hoe will save backache in large gardens. You'll find a man-size trowel, weeder, hatchet, and short-handled hoe valuable.

Have you ever turned a shovelful of soil? Irksome, isn't it? Well, here's a way to reduce strain and get more enjoyment from this necessary part of the job. Suppose you are single-trench spading. This means that you make a trench about 6″ wide and 12″ deep along one side of the plot, tossing the

Water can be hosed quickly into furrows with no danger of breaking them down by using a 1-gal. can as shown above. Cut two holes in opposite sides of the can for the flow to go through, and hold the hose low in the can



Two pointed sticks nailed at proper intervals on a longer stick will help in making shallow parallel trenches in turned soil or on a raised bed. A good guide for keeping the trenches straight is a garden line strung down the center for the length of the rows

Seedlings are transplanted in holes dug with a sharp stick or similar tool. Make the holes large enough for the roots to be dispersed without crowding to aid maximum early growth

Furrow beds 4" wide are best for planting peas, which should be scattered out. Hoe the dry soil on top to one side, the moist to the other, and replace the moist soil first in covering the seed

soil removed ahead of you. Force the spade or fork deep into the earth by stepping on the shoulder, working a 6" strip. Turn each load over, placing half in the trench, half on the shoulder. Thus you leave a new trench as you work across the garden. To ease the task, stand so you can use the right knee and upper leg as a lever. Press upward with the knee, down on the handle with the hands.

A certain amount of enrichment is usually necessary in preparing the soil, but do not use too much. For each 10′ by 10′ space, broadcast from 100 to 150 lbs. of barnyard manure, or else 10 lbs. of sheep manure, 10 lbs. of poultry droppings, or 5 lbs. of commercial fertilizer. Spread any one of these evenly over the entire plot, and spade in as deeply as possible. The natural fertilizers provide humus for the soil and also take care of the more important plant needs. They may be easier to get than artificial fertilizers.

Besides these, compost is a third food source. Keep it in a bin, about 8′ square and 4′ high, with either an earth or a concrete floor. Throw in plant refuse, kitchen waste, and wood ashes, and wet regularly with water. Slaked lime will hasten decay. If preferred, the refuse may be piled in a

corner of the garden and covered with a thin layer of earth.

In most sections, the ground probably will have enough moisture in the spring to require little besides a thorough digging along with the fertilizing. Pulverize it well, casting the upper soil to the bottom of the trench. Do not work it too early because this tends to form a hard crust over the seed, holding back germination.

If you live in a dry area, such as some sections of California and the Southwest, irrigating before planting may be necessary. Be sure to examine the soil first with a spade to determine the amount of moisture beneath the surface, for early irrigation may also form a hard crust.

To flood dry plots before planting, "check up" the area in beds about 4′ by 5′, throwing up borders with the hoe 8″ high. Fill each check at least once. For heavy soils use ditches 2′ to 3′ apart. When flooded soil is ready to work, break down the borders and, after a few days, spade or plow.

A pipe tee fitted on the hose coupling and wrapped loosely in heavy cloth at the joint will help in flooding, or simply wrap several layers of sacking around the hose outlet.

Tall-growing vegetables are planted in rows 30″ apart, while the smaller root and leafy vegetables may be planted closer. If space is at a premium, the rows may be as close as 12″, but this does not give much working space between them.

If you prefer to plant on raised beds, have them just far enough apart for working. Level the plot first; then stretch garden lines from the ends of two stakes placed horizontally at opposite ends of your plot. Short stakes driven at each end of the 30″ ones will hold them. Now, walking backward, plunge the hoe into the soil with the cutting edge away from the guide line and draw the soil up sharply. Repeat the process along the other line, thus completing the first raised bed. For the second bed, complete the second furrow and start a third. Each bed must be smoothed level.

The seeds should be planted on the shoulders in parallel, shallow trenches. Two pointed sticks nailed at the proper intervals to a horizontal stick about 15″ long may be drawn along the surface of the bed to make the trenches. A flat board, with a small stick projecting downward at one end, or a metal planter will also serve. The garden lines make a good guide.

Double-row crops include carrots, turnips, beets, parsnips, radishes, spinach, celery, mustard, onions, and Chinese cabbage. After planting, fill the furrows carefully but firmly and do not sprinkle. Sow plenty of seed; then thin to keep the stronger plants.

Peas are usually planted in single rows, especially for trellising. The furrow bed should be about 4″ wide so the seed can be scattered out. With a hoe, scrape the drier top soil to one side and the moist to the

Short rows of peas may be trellised inexpensively on nets sold for the purpose at seed stores. Tied at the ends to two stakes, a net provides adequate support for the vines

Another method of forming seed furrows in turned soil is with a metal planter. The bed layout lines serve as guides

If you want early vegetables, cover the transplanted seedlings with "hot caps," little waxed-paper mounds that keep them warm at night and moist during the day

Ten Garden Tips

1. BEANS prefer heavy soil to looms. Plant seed 1" deep in clay, 3" in sandy soils
2. BEETS like mellow soil. Soak seed 24 hours before planting to hasten the germination
3. CABBAGES require strong, fertile soil, not sandy loam. Start them in a seed bed, and then transplant seven to eight weeks later
4. CARROTS need light, moist, warm soil. Mix sand with seed and do not sow over ½" deep
5. CORN dislikes frost. It does best in rich, sandy loam. Plant 4" apart, 1" to 3" deep
6. LETTUCE will grow in nearly any soil if kept moist. Shade from other plants helps in hot weather. Transplant or sow and thin
7. CUCUMBERS take to a rich soil. Plant after frost, and keep the three strongest plants of the five or six sprouting in each hill
8. TOMATOES are universal, growing well in any soil but light sand. Transplant after all danger of frost is past, spacing 3' apart
9. TURNIPS should never go in clayey soil or sand. Plant preferably in rich soil like other root vegetables and thin to 3". An early planting is better than one in summer
10. SQUASH should be irrigated from furrows, never by sprinkling. Pick before too large

other. Plant ½" deep in spring, 2" during warmer months. Put the moist soil back first, the dry on top. Mulch and do not disturb again until the sprouts appear.

Tomato, pepper, cabbage, lettuce, and some other plants have small, fibrous roots, and are quick to make new growth when transplanted. Growing them in flats is comparatively simple. Use shallow boxes about 4" by 24" by 24". Sterilize the soil by drenching with boiling water, and immerse the flats and other equipment in boiling water for five minutes. Make up the soil from sterilized garden soil and a handful of screened sheep manure, leaf mold, or peat. Mix thoroughly and firm down in the flats until the surface is ¾" below the top. Plant seed from ⅛" to ¼" deep, according to the variety, and cover with screened light soil mixed with manure or leaf mold. Protect with burlap until the seedlings pop up.

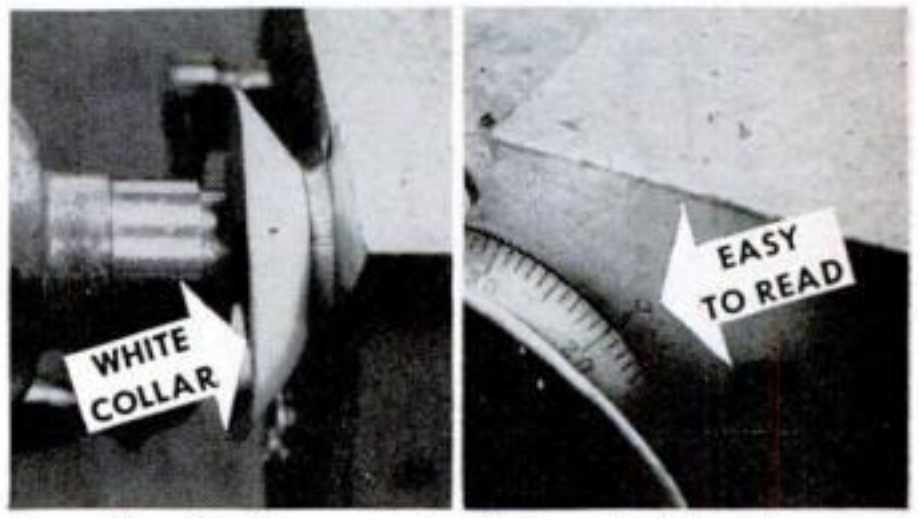
When the plants are 1" high, transfer to a second flat, planting 1" apart. Never sprinkle, but "irrigate" by placing the flat in shallow water until it works up to moisten the surface. Transplant in the garden during a cool evening to avoid wilting. Use a sharp stick or other implement to make holes large enough for the roots to be inserted without crowding.

Once your garden is started, water becomes most essential. It is a good idea to cultivate four or five days after each rain or watering. The hose need be used only every 10 days or so in the spring, and every four to eight days in the summer.

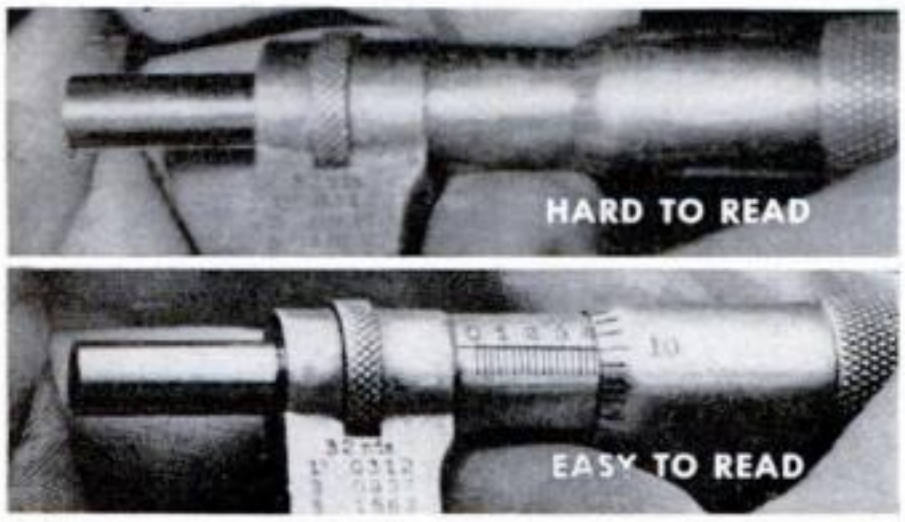
Dusting young plants is essential when they are threatened by insects. The powder can be put on evenly by shaking from an ordinary sack

HOW Light Helps Speed WAR PRODUCTION!

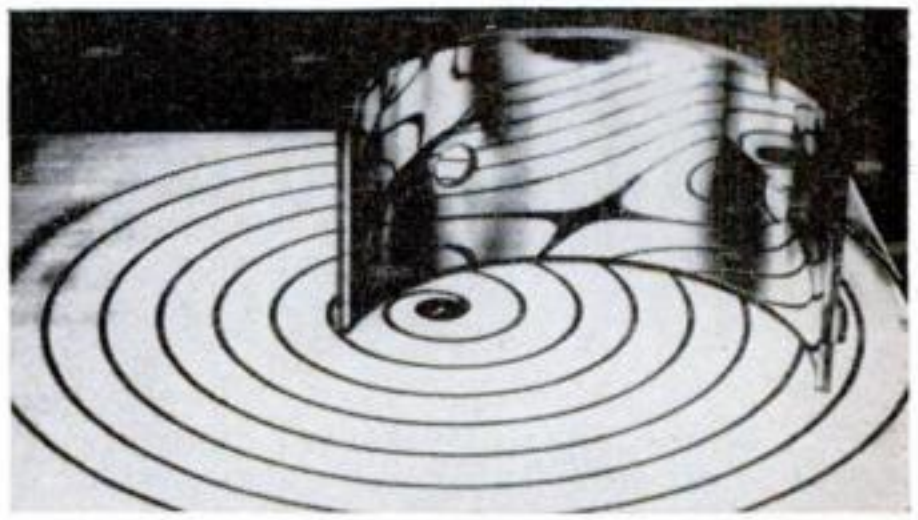
Spots snags. Smooth, silhouetting light from recessed G-E MAZDA Fluorescent lamps covered with sanded glass makes it easy to locate weak spots in parachute material . . . and do it fast.



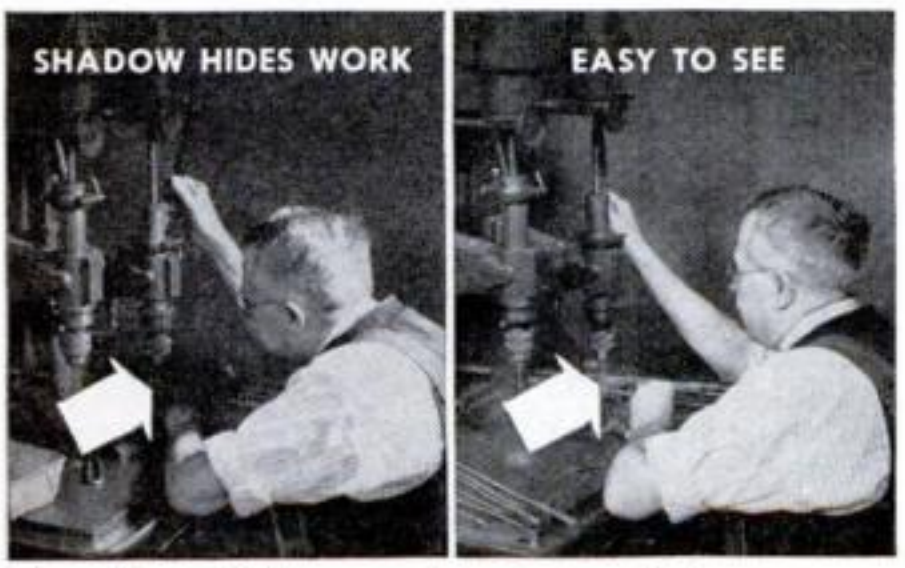
Saves time. Shadows on the dial made it hard to read. But a white collar placed around the dial shaft at a 45° angle reflects light on the scale to speed seeing, increase accuracy, reduce fatigue.



Makes "mikes" talk . . . and talk plainly. In many a war plant confusing reflections on the barrel of a micrometer make it hard to read. But under a large area source, of low brightness, the figures stand out clearly.



Tattle-tale. Inspecting a polished bearing surface is tough under ordinary light. But place it on a smoothly lighted diffusing glass with lines on it; clean-cut reflections say "OK", distortion says "roughness".



Gloom chaser. When you have to work in your own shadow, you strain to see, make more mistakes. But move the lighting fixture slightly, to put the light where it helps and you can *see* the difference!

Write for a copy of the new booklet "How Light Can Speed Victory". Gives many practical suggestions on lighting for production. Write Dept. 166-PS, General Electric, Nela Park, Cleveland, Ohio.

Made to stay brighter longer

G-E MAZDA LAMPS

GENERAL ELECTRIC

Look Out, Hitler!

(Continued from page 81)

factor is that Willow Run, no matter how big, is still only one part of the Ford empire. When forgings and castings are needed in a hurry, they can be whipped out quickly, at the River Rouge plant without any waiting. When special problems arise, specialists, laboratories, and instruments are available.

Those are the advantages of Willow Run as it moves in to stack its productive capacity alongside that of the established aircraft industry. Its great disadvantage has been inexperienced manpower. Generally speaking, it has been necessary to train the thousands of workers right from the fundamentals up. The plant's apprentice school was started long before the factory was complete, and employee attendance at school today exceeds 8,000 student hours a week.

The crucial shortage is in experienced production men, men who know how to organize the sequence of operations and get them moving. While Willow Run was getting ready to start, many such men were snapped up by other plants and other industries. However, despite rumors and criticisms to the contrary, it can be stated at this writing that Willow Run is running on schedule; in quantity and in quality its output is up to the standard set for it in advance. By its very nature, mass production takes a long time to get started; but when it moves, it moves fast!

Up to now, Willow Run's capacity for making parts far exceeds its final assembly output. For one thing, the place was originally projected as a parts plant, for making subassemblies to be shipped to final plants in Texas and Oklahoma. Planes are moving in this way now in great trailers designed for the purpose—vans big enough to enclose a 60-foot center wing section. Two of these road freighters, 73 feet over all for tractor and trailer, carry all but the engines of one B-24. They are moving monuments to the way some production planners were thinking in the days before the rubber and gasoline shortages.

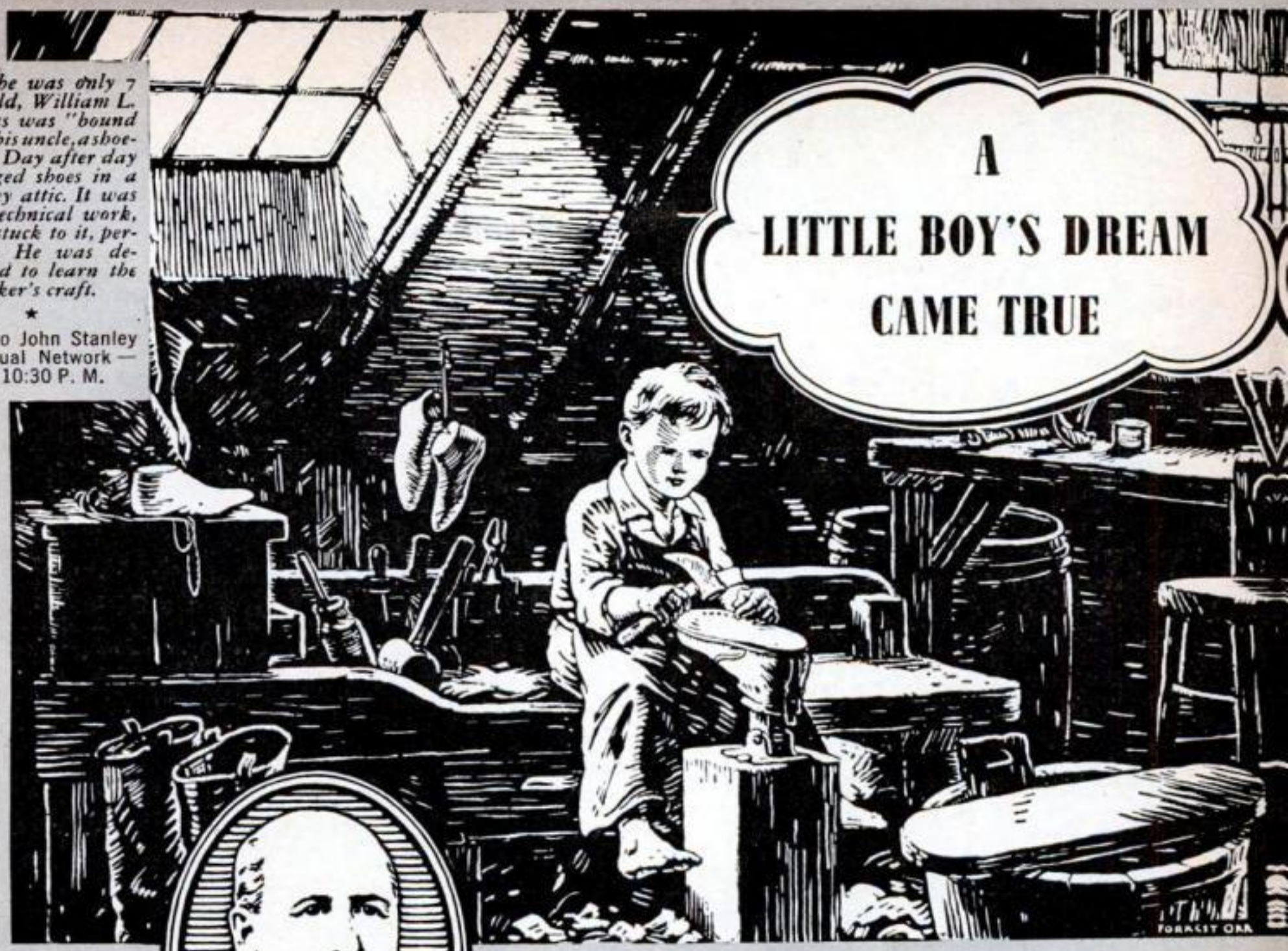
That way of thinking seems to be on the way out. The final assembly line is taking more and more "parts." The river is high on the banks of the tributaries upstream. Farther down it's about time for the flood.

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

When he was only 7 years old, William L. Douglas was "bound out" to his uncle, a shoemaker. Day after day he pegged shoes in a shadowy attic. It was hard, technical work, but he stuck to it, persevered. He was determined to learn the shoemaker's craft.

★

Listen to John Stanley on Mutual Network — Sunday 10:30 P. M.



The Commander
Service men and civilians choose this tan military type oxford, for all-day walking comfort. No. 4563. In black No. 4035.

The Colonel
Ever popular military buckle oxford, in soft durable tan leather; with rugged leather sole. Smart for dress or street wear. No. 4538.

Douglas "Down-to-the-wood" construction assures you better fit.

$6.50 - $8.50

Other styles at **$5.50**

— and you can see the difference . . .
today more than ever . . . in even
W. L. Douglas Shoe you buy

The story of W. L. Douglas is a story of sturdy pe severance and of plain hard work. But it is most all the story of an ideal — of a little boy's drea that came true.

Yes, there's the touch of young Douglas in eve W. L. Douglas shoe you buy today. That's wh you like them the instant you slip them o Like the way they feel, the way they loo Their honest durability and characte That's your assurance that Douglas sho are still, as ever, W. L. Douglas sho Buy a pair today.

LET'S GO! U.S.A. KEEP 'EM FLYING!

W. L. **Douglas Shoes**

W. L. DOUGLAS SHOE CO., BROCKTON, MAS

Stores in Principal Cities - Good Dealers Everywhe

SINCE 1876 — W. L. DOUGLAS — AMERICA'S BEST KNOWN SHOES

BUY WAR BONDS AND STAMPS FOR VICTORY BUY W. L. DOUGLAS SHOES FOR W

America's Ace in the Hole

(Continued from page 105)

nuisance that coats the catalyst so that there is less and less contact between it and the feed stock.

To stop a still every ten minutes or so, pull out the weakened catalyst, put in fresh, and start over would slow down the operation. Clearly, what engineers needed was a process for *continuous* catalytic cracking.

The first to make headlines with a solution was Eugene Houdry, a 50-year-old French engineer. In the Houdry process cracking is done in three identical stills, called "cases," connected by a system of pipes and valves. Once every ten minutes, the cases change place in the operation. While cracking is taking place in one, the second is being emptied and cleaned, while in the third, the catalyst is being regenerated by burning the coke out of it with air. Until this year, 90 per cent of the synthetic high-octane fuel for our war planes came from Houdry plants.

Houdry engineers have greatly refined the original process. A big slice of the "makings" of both synthetic rubber and aviation super-fuels will soon be pouring from improved Houdry plants.

Another improvement on the Houdry process is the Thermofor catalytic cracking, or T.C.C. process, worked out by engineers of the Socony-Vacuum Oil Company. T.C.C. makes use of an ingenious device for regenerating the spent catalyst. The catalyst itself is in pellets about the size of birdshot. It is carried back and forth between cracking still and regenerating chamber on continuous conveyors.

Temperatures in the regenerating chamber run up to 1,100 degrees Fahrenheit, far higher than in actual cracking. The chamber is filled by a series of vertical, hollow tubes, with spiral fins running around them. Poured in from the top of the chamber, the catalyst rolls down over the *upper* surface of the spiral fins, the air that promotes burning rushes upward along the *under* side of the same fins, and molten salt or some other heat-transfer aid is passed *through* the hollow tubes to help control temperature. Versatile as a one-man band, the tubes of the Thermofor kiln do three jobs at once!

Just warming up to full production are the first three of 33 great cracking plants using the "fluid catalyst" system developed by engineers of the Standard Oil Development Company. Automatic control has been brought to such a fine point that the new

(Continued on page 206)

MILITARY AIRCRAFT SPARK PLUG

AUTOMOTIVE SPARK PLUG

BOMBING RAIDS F.O.B. Flint, Mich.

"MISSION ACCOMPLISHED"—and safe return! *Both* depend heavily on aircraft spark plugs. So, those which AC produces for the Army Air Forces must be painstakingly built to the exactness and reliability of the finest watch.

AC has been building quality and performance into automotive spark plugs for more than 34 years. It was only logical, therefore, that AC should make aircraft plugs for Army planes.

But, a pilot's success requires still more. Those plugs must be *kept* in peak condition. So, ground crews clean and adjust plugs after a specified number of operating hours.

Expert Care for YOUR Spark Plugs

These days, your spark plugs should be given similar care. And this is easy—through the Conservation Service which America's mechanics are rendering. This is now being augmented by contacts from AC, carrying to all service organizations the latest and most practical methods of diagnosis and repair of AC products.

The service which spark plugs, and the eight other AC automotive products, should receive is briefly described in the panel below. Help to conserve vital materials—and gasoline, oil, and rubber—by regularly following the suggestions given.

When replacement is needed, select AC—and be sure of complete satisfaction.

AC SPARK PLUG DIVISION—GENERAL MOTORS CORPORATION

Awarded to AC on September 2, 1942, for outstanding achievement in producing for Victory.

AC SPARK PLUGS

OIL FILTERS—Slow driving accelerates the formation of soot and carbon in engine oil. If not constantly filtered from the oil, this dirt will clog piston rings, which causes increased consumption of oil and gas. So, replace your oil filter element whenever your dealer's AC Oil Test Pad shows that your oil is dirty.

SPARK PLUGS—Dirty or worn plugs waste as much gas as one coupon in ten. They also cause hard starting which weakens your battery. Under present slow driving conditions, have your plugs cleaned and adjusted every few months.

AIR CLEANERS—A dirty air cleaner increases gasoline consumption because it chokes down the flow of air into the carburetor. Your air cleaner should be rinsed whenever your car is lubricated.

FUEL PUMPS—Practically trouble free. But, if yours has been in use thirty or forty thousand miles, it may be worn to the point where a check-up is due.

DRIVING INSTRUMENTS—Speedometer, gasoline gauge, oil pressure gauge, ammeter, and temperature gauge seldom need service. But, if they give trouble, have them cared for *at once*.

America's Ace in the Hole

(Continued from page 204)

plants, as large as New York City's biggest skyscrapers, are operated by nine men facing a long row of dials and buttons in a central control room.

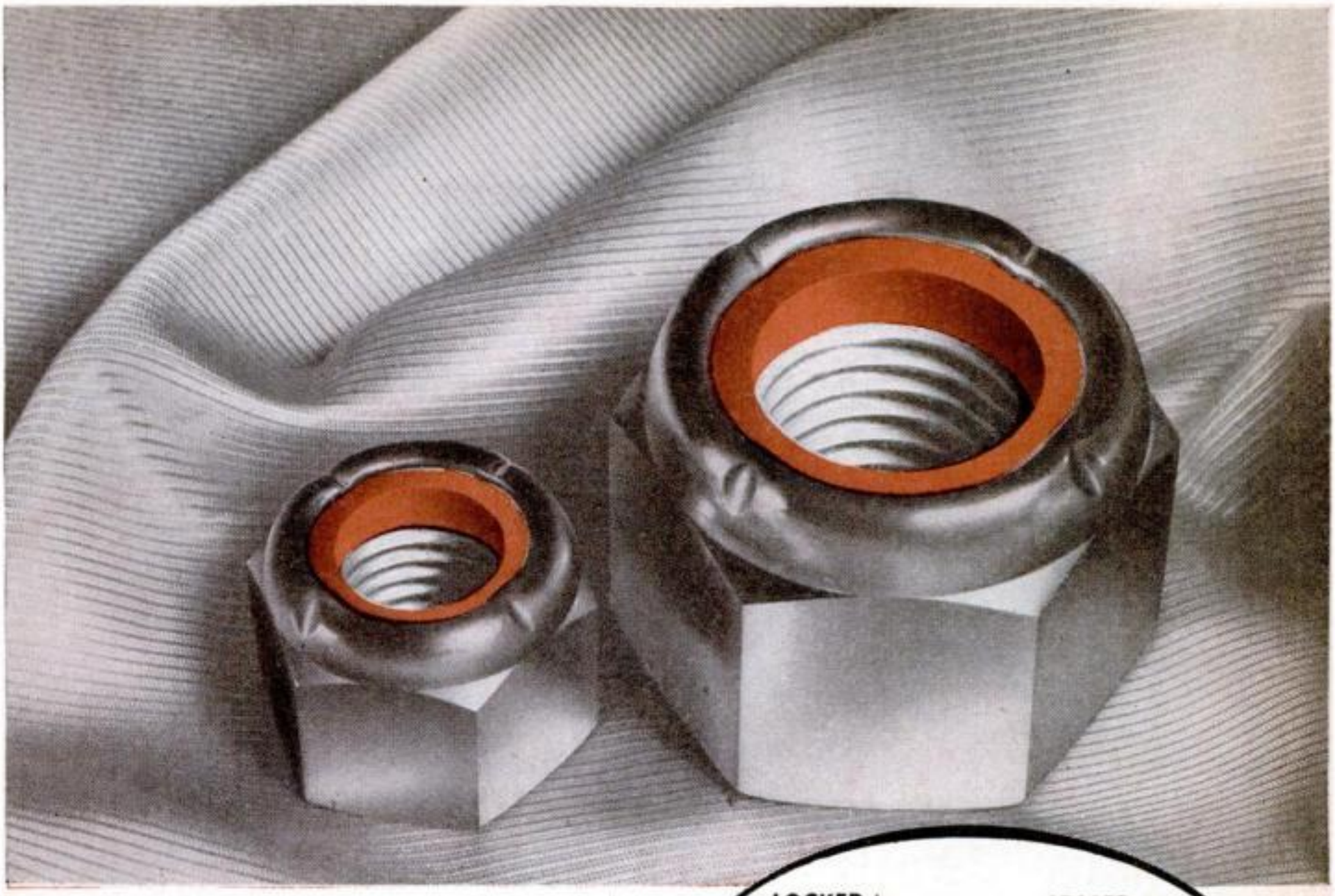
While the "fluid catalyst" flows, it is not a fluid, but a powder, with particles as small as .00004 of an inch. If you put a fine powder in a standpipe and force compressed air in from the bottom, the powder will begin to rise slowly in the tube as the air mixes with it. When air and solid are thoroughly mixed, open the bottom of the tube and the mixture will *flow* out as though it were fluid. You have probably seen smoke—a mixture of carbon particles and air—behave that way.

That is precisely what happens in the new "cat cracker." The catalyst *flows* out of the tube into a pipe that carries it to the bottom of the three-story vessel where the oil is cracked. The fineness of the powder means high efficiency in cracking—particles of catalyst and molecules of oil are closely intermingled.

Cracked oil and catalyst are drawn off at the top of the vessel. A battery of cyclone separators whirls them apart and sends each on its way.

Fluid "cat cracking" is a two-cycle operation. The cracked oil goes on to be separated into gases and liquids, the gases to go to an absorbtion plant and the liquids to a fractionating tower. The catalyst returns to the cracking still by way of a regenerating chamber where the coke is burned out, another battery of separators, and a precipitator where it is rid of accumulated gases. Within a few months, fluid "cat cracking" will be contributing a major share of our rubber and our superfuels.

It's engineering work like that that is building this nation into the world's first military power. The 100-octane, the rubber, and the toluene from such plants are going to decide the last round in this war. Those new plants are going to bring into our daily lives many things that only yesterday were laboratory curiosities. They are going to knock many of our old-fashioned ideas about oil into a cocked hat. So oil and water won't mix? Plenty of the chemicals being from oil today are water-soluble. It's a far cry from soap to Vitamin E, 100-octane gasoline, roofing, and marvelous new motor oils that (by addition of a chemical made from oil) will do their work at 60 degrees below zero! A far cry, but they all come out of the same barrel!



WHAT IS A NUT?

A nut is a fastening.

Its purpose is to hold things together.

If it loosens, breaks or slips under strain, stress or vibration, it fails in its purpose.

But here is a nut which has never failed in service.

It holds tight, even when removed and put back many times.

We have made billions of these Elastic Stop Nuts. We do not know of one that has fallen down in its job.

We do not believe that statement can be made about any other nut.

ELASTIC STOP NUTS

Lock fast to make things last

ESNA TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA
UNION, NEW JERSEY

Power Mowers take a beating from vibration — but Elastic Stop Nuts have already shown they can hold their own in such uses.

When regular nuts loosen, cars squeak. So look ahead to quieter automobiles after victory is won.

Troopers on Wheels

(Continued from page 52)

operator not only is alert to receive messages and quick on the transmission, but will systematically monitor his radio nets to pick up collateral information about what is going on at the flanks or with other scout cars in the net. He also keeps track of where the car is at any given time, looks back frequently to orient himself on the map board, and in an emergency can jump up to replace one of the gunners.

All cavalry equipment is in a continuous process of improvement. Thus the six-ton M3A1 scout car itself, while admittedly a very handy vehicle, is regarded in the Army as more or less obsolescent, and it is no secret that a more modern combat car will soon take its place, endowed with heavier armor, greater fire power, and superior ground-covering qualities. If the old scout car had a real fault, it was in lacking versatility and power across country. Our commanders hate nothing worse than the spectacle of U. S. Army units getting "road-bound" and unable to move across fields and intervening terrain to strike back on a road beyond enemy blocks.

Elementary in the new cavalry technique is the "advance by bounds," in which one car studies the terrain ahead, and then rushes at full speed to the next covered point—a hill crest or road turn—while the following car waits to cover its move with fire. That accomplished, the section makes another bound ahead, accommodating its maneuvers always to the terrain in which it is operating.

In dangerous territory, where the road is broken and enemy resistance may be encountered at any point, the cars may turn around in the road and back up to the danger point, thus bringing heavy fire power to bear over the peak of a hill and maintaining themselves in position to withdraw swiftly from a hot spot.

When reconnoitering a village or enemy camp, the cavalrymen try to do their observation from the extreme flank or rear. If an ambush is suspected on a road ahead, they again prefer the safe method of dismounted reconnaissance from the flank, but if time is pressing they will switch tactics and send a car in to slash through while other vehicles cover the suspected zones with fire.

More complex operations are not ready for public discussion now. It should be enough to set down for the record that the American cavalryman is a tough hombre on wheels today—he already was tough!

You may worry about the size of your steak

. . . but here is one worry you can avoid

A BIG, juicy, pre-war steak is hard to get these days. So is a new car. That's why it pays to take *extra* care to avoid *extra* wear on your car's king pins, tie rods, steering crank bearings and other vital friction points that mean costly repair bills when neglected! Play safe—with Marfak chassis lubrication every 1,000 miles!

Marfak helps add miles to your car's life. It's super-tough. It "stays put." It resists wear-out, wash-out and squeeze-out.

To insure *worry-free* protection, Marfak is accurately applied by chart, never by chance.

For your peace of mind, never say "grease job." Insist on genuine Marfak Chassis Lubrication. At Texaco and other good dealers everywhere.

TUNE IN: FRED ALLEN every Sunday night. See your local newspaper for time and station.

You're Welcome at **TEXACO DEALERS**

The Liberator

(Continued from page 90)

Not much was left of Model 31 when the first Liberator flew, except for the all-important item of the wing. As for weight, she originally was scheduled to tip the scales for a gross weight of 39,000 pounds. Shortly this was upped by a large amount.

You've got to look closely at that wing for the main reason why Miss Liberator not only flies farther and faster than other heavy bombers, but also can lift heavier loads than her predecessors. David R. Davis gave Miss Liberator her wing. Davis, once partner of Donald Douglas, upset all previous theories of wing design when he sold Major Fleet on an idea he promised would give him a swifter bomber than man had yet conceived.

To know about wings, you've got to understand that the efficiency of a wing depends upon its silhouette and its airfoil, airfoil meaning a cross section which shows the curvature of its surfaces. Precisely the form taken by the Davis wing can't be told in a few sentences. Nothing less than a complex formula would convey the idea, even to an aeronautical engineer.

Nubbin of the idea, though, is this: Davis theorized that, contrary to the accepted thought, a wing has a positive action as it moves through the air, and its seemingly passive action is due to the fact it is held passive by the plane's controls. From this he concluded that, were a wing not held passive, it would revolve like a wheel around a hub. He reasoned further that a wheel, properly modified, could be applied to airfoil design. His wing, then, can be considered a modified circle, which may be varied to carry heavier loads, fly faster, or perform whatever mission it may be called upon to fulfill.

Davis' wing was submitted to the California Institute of Technology wind tunnel, and to their amazement the scientists found that it tested, not 90 percent efficient, which had been about the best for any other airfoil, but hit the unbelievable figure of 100 percent! They could scarcely believe their own calculations, and almost tore the tunnel down in an effort to learn whether their structure had contributed to an erroneous total. But the figure stood, and when it was applied to the Model 31 flying boat, the boat took off like a land plane after an almost incredibly short run.

Exactly what that wing might contribute to America's war effort was not immediately apparent, because we were not at war

(Continued on page 212)

The Liberator

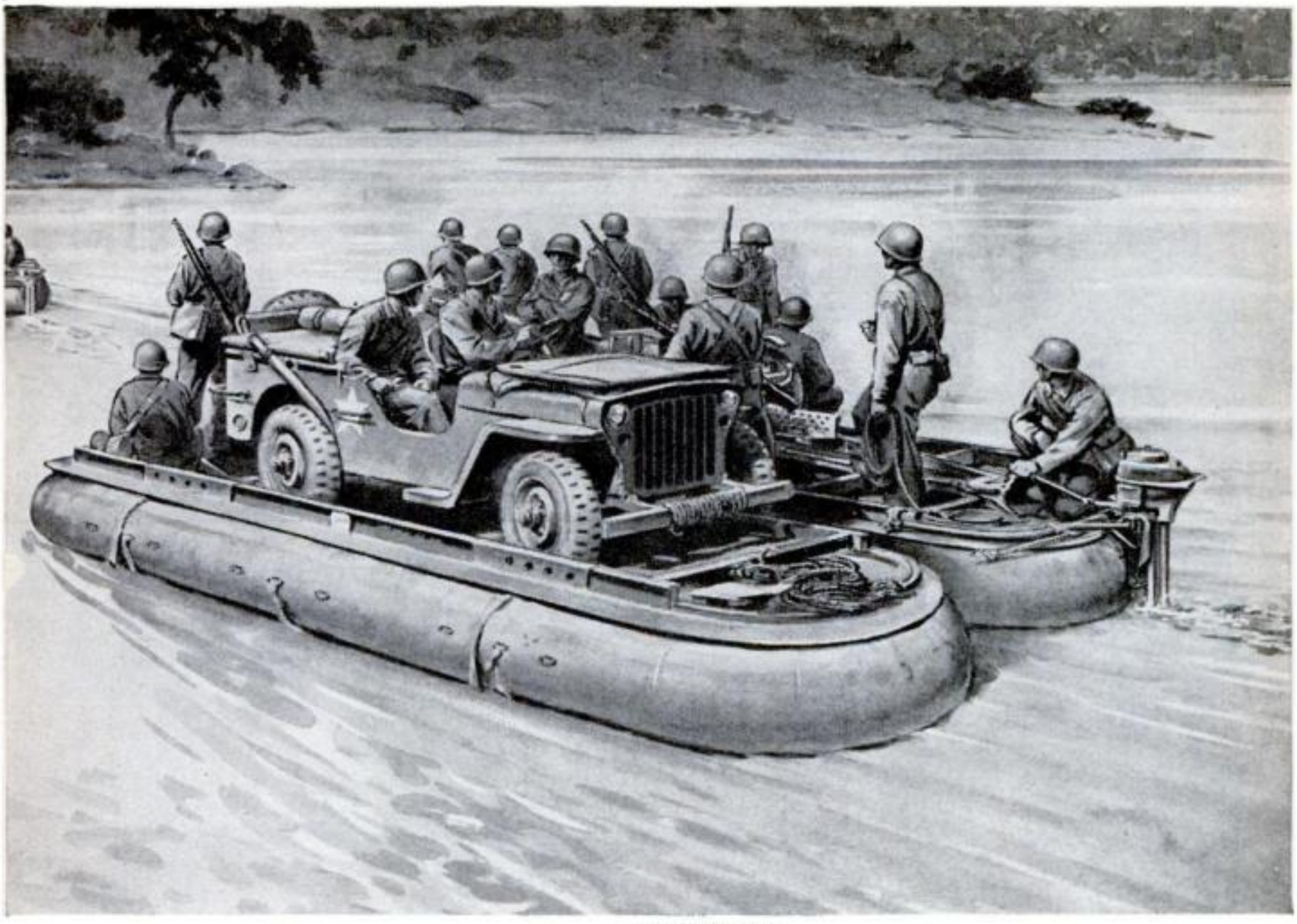
(Continued from page 210)

and were not building big bombers in large numbers. In December, 1939, though, the nation got a preview of earth-jarring events to come, when the first B-24 was launched. To engineers, that ship promised great things in the field of long-range flying and bombing enemy bases a long way from our bases with fairly heavy loads of deadly explosives.

Here you've got to consider another set of facts about airplanes to understand why Consolidated engineers were and still are jubilant. Because we're coming to a new era of even larger bombers, we'll talk in big terms. Most planes, remember, carry a useful load about equal to their own weight. A bomber weighing 40,000 pounds ordinarily will carry 40,000 pounds of bombs, fuel, personnel, and equipment. Now, if the wing's efficiency can be increased 20 percent, which just about represents the Davis wing's superiority over others, that ship will pick up a 40-percent heavier load, or an additional eight tons. Because the Davis wing has been found especially good as a load-lifter, we can justifiably look forward to Liberators' big brothers some day carrying bomb loads far heavier than we've envisioned in the past—and carrying them right into the heart of Germany and Japan.

The Liberator line is a dogged breed, as one would expect from a warplane that has proved its valor by great deeds. One is reported by the British to have flown 745,000 miles—30 times around the world—during the past year. An adaptation, the C-87, flew 2,200 miles from Newfoundland to England in 400 minutes, spanning the Atlantic at 330 miles an hour. Another C-87 flew Wendell Willkie from London to Moscow to Cairo. General Arnold flew in a C-87 from Australia to San Francisco in 35 hours, 53 minutes, establishing a world's record for that long over-water flight.

The C-87, called the "Express Liberator," is a cargo and personnel carrier. Except for a few changes, it is the B-24. Bomb bays have been removed and windows installed. A new nose replaces the bombardier's plastic windows. Obstructions have been taken out and doors cut in her sides. Though a land plane, she's been flying scheduled ocean runs since last August, hurrying officers, ammunition, and repair parts to advanced bases. She's helping the B-24 perform her important job. The qualities that make her so useful are the same ones that fit her bomber sister to be the Liberator in fact as well as in name.



Taking the Jeeps over the Jumps!

PRODIGIOUS jumpers that they are, our fighting Jeeps still can't jump broad rivers. So the Army's resourceful Engineers find still another job for their Evinrudes! Huge rubber rafts are bridged in tandem . . . Jeeps and troops are loaded aboard . . . husky Evinrudes sing their deep-throated song of power . . . and quickly the Jeeps are over another jump!

Giving a lift to the leaping Jeeps is but one of many wartime jobs which Evinrudes are performing today. For Evinrudes are *enlisted for the duration* . . . in the Army, the Navy, the Marine Corps. Great Evinrude "Fours" power swift assault craft and landing boats. Evinrudes help build bridges, ferry supplies, troops, equipment. Mountbatten's famed Commandos know their power, rugged reliability and trigger-quick starting ease.

All the experience gained in 33 years of building fine outboards is centered on our assignments to build Evinrudes for the armed services. Knowledge of some of the tasks these motors must perform is an ever-pressing incentive to build them finer . . . and still finer! *After Victory,* there will again be Evinrudes for all who love the water . . . sparkling new Evinrudes whose performance will ably reflect many advancements achieved in their fighting forebears!

EVINRUDE MOTORS, Milwaukee, Wisconsin

Evinrude Motors of Canada, Peterboro, Canada

EVINRUDE

OUTBOARD MOTORS

★ *Invest in America! Every War Bond you buy helps speed the day of Victory. Then, good fishing to you.*

Answer to Air Power

(Continued from page 72)

tecting the infantry in river crossings or in ravines; protecting supply dumps and armored supply trains.

Taking advantage of ground that favors concealment whenever possible, their share in carrying the fight to the enemy will be to go where hostile planes may be expected, and to shoot them down when they come within range.

More fire power against airplanes is being placed in the hands of the infantry, engineers, and armored troops, to supplement that of the ack-ack battalions. Newly designed tactical vehicles for all these arms are having emplacements for .50 caliber machine guns built into them. So in our ground forces, one man in ten may be found equipped and ready to fight hostile aircraft, before the war ends.

Not only will guns go forward, but searchlights and barrage balloons, too. They will be flown to the farthest advanced air fields, just back of the airborne engineers. Emphasis of American military thought just now lies upon very-low-altitude balloons, to fly above troops, trains, ships, airfields, and landing strips. These are about half the size of the big "flying elephants" used to guard docks and factories. Quickly raised and lowered from jungle airfields, they can free our fighting planes from some burdens of defense.

Our searchlights, throwing 800,000,000 candlepower of light, nine miles high under favorable conditions, from their five-foot reflecting mirrors, are essential to the team.

But the new guns, mechanically directed, massed, and mobile, in quantity enough wherever they are needed, are the ultimate answer to enemy air power. Working with our own air and ground forces as a tactical team, as they are now being trained to work, our antiaircraft troops can help win the war where ultimate victory has to be won—on the ground, on enemy soil.

Peppermint Pills Prevent Overdose of Sulfa Drugs

WOUNDED soldiers who have to take sulfa drugs internally are protected against a harmful overdose by an ingenious plan devised by the U. S. Army Medical Corps. The drugs are given in pills strongly flavored with peppermint. By smelling the injured man's breath, a medical soldier can tell whether he has had a dose so recently that another one would be inadvisable.

$1,000 FOR YOUR IDEAS In the Big Marlin Gun Contest!

Now here's a chance for you hunters and target shooting fans, to *cash in* on your knowledge of guns! Marlin—always on the lookout for new ideas to improve sporting firearms—wants to hear from you. Sportsmen and gun dealers are cordially invited to join Marlin's big Gun Contest—with $1,000 in cash prizes to shoot at. And remember, many a good idea is simple and easy to describe. Your chance is as good as the next fellow's to win a prize. It's easy to get in the contest—read the details below and send your entry in today! Contest ends July 1, 1943.

Jot down your ideas for improving any current model Marlin Gun. Follow the simple contest rules and send your entry in. If you wish, you may suggest new features, not at present in the line. A free catalog is yours for the asking, to review the features of Marlin Guns.

PRIZES IN THE BIG MARLIN CONTEST

The first prize is $500.00 in cash; second prize $100; third prize $50.00; fourteen additional prizes of $25.00 cash each. Seventeen prizes in all! (Marlin suggests the purchase of U.S. Savings Bonds with the prize money.)

JUDGING

Three famous gun editors—Bob Nichols of Field & Stream, Jack O'Connor of Outdoor Life, Maj. Chas. Askins of Sports Afield—will select the winning entries. All ideas for which prizes are given become the property of The Marlin Firearms Company and none will be returned. Prizes awarded for the seventeen ideas which are most valuable and practical, in the opinion of the judges. Duplicate prizes awarded in the event of a tie. WINNERS will be determined and prizes announced as soon as possible.

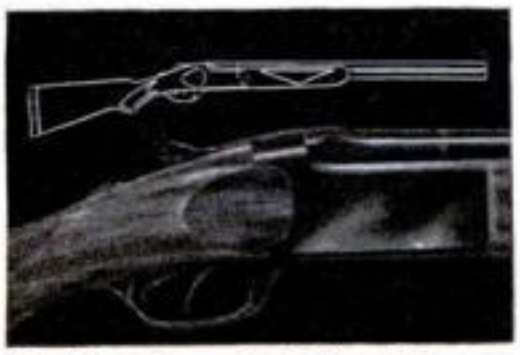
CONTEST RULES

The Marlin Gun Contest is open to all sportsmen and dealers in guns, with the exception of Marlin employees. Written suggestions must not exceed 300 words, the shorter the better. No limit to number of entries which may be submitted. Write name and address clearly on each suggestion. Mail entries to Dept. K, The Marlin Firearms Co., 17 E. 42nd St., New York City.

Entries must be received on or before July 1, 1943.

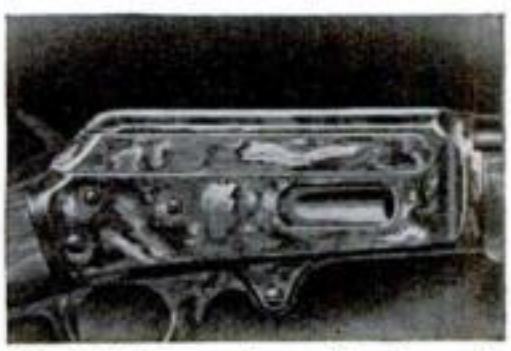
Win cash with your ideas! Enter the Marlin Contest today.

The Marlin Firearms plant is now 100% on war production.

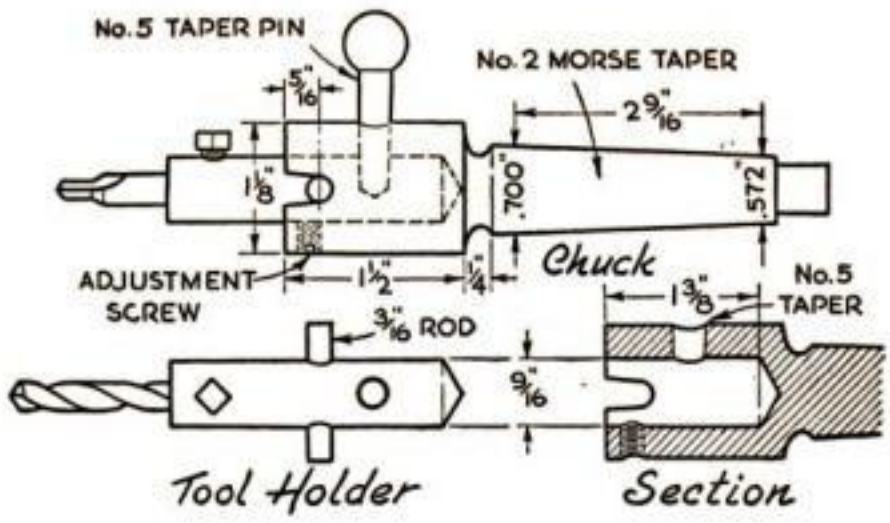


Marlin's Over & Under Shotgun, in 12, 16 and 20 gauges and .410 bore, is hammerless, cocks on opening, has sturdy one-piece frame.

All Marlin rifles—lever action, clip and tubular magazine and .22 automatic, feature deep-cut, accurate, "Ballard" rifling.



Marlin lever action rifles, in calibers .22, .30-.30 and .32 spec., have the solid-top, case-hardened receiver, with safe side ejection.



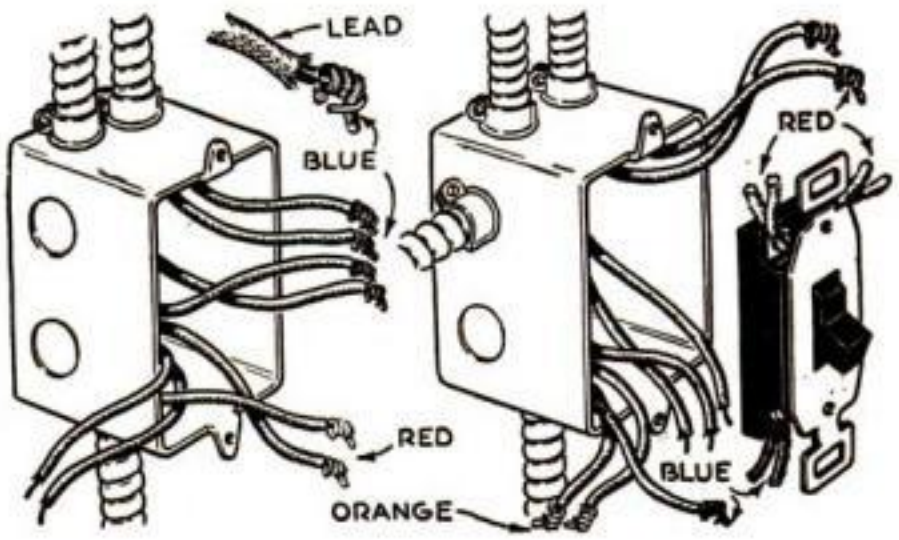
Quick-Change Tailstock Chuck Speeds Duplicate Work

THIS quick-change tailstock chuck saves much time in machining duplicate parts with tools held in the tailstock. A set of tool holders to hold drills of various sizes, special cutters, or taps should be made up.

Turn the chuck from tool steel if possible, so that it may be hardened for heavy service. Slip it into the headstock spindle to drill out the hole for the tool holders.

Drill a 3/16" hole on a true diameter 5/16" from the end, and saw down to this to form the notches for the tool-holder pin. A 3/16" setscrew provides for adjusting tool holders precisely to lathe center height.

The holders can be accurately center-drilled for tools while held in the chuck, the latter being inserted in the live spindle.



Colored Pipe Cleaners Mark Electrical Wire Leads

HOUSEHOLDERS who have to repair or make minor changes in their house wiring will find colored pipe cleaners useful to identify wire leads, as shown above.

After breaking a splice, simply wind a short length of pipe cleaner of the same color around each of the leads of that splice, and use a different color for each splice. Then you can work freely without fear of tearing off the markers, as might easily

(Continued on page 218)

Vital GUNS to all Corners of the Earth

As in 1917, our technical skill and large production capacity are devoted to the cause of winning a war.

Vast quantities of precision-built Browning machine guns are pouring forth to arm the rapidly growing fleets of bomber and fighter planes that are now attacking and bewildering the enemy in all corners of the globe.

Thompson submachine guns and military rifles are coming in continuous streams from round-the-clock production lines . . . vital equipment for Allied forces everywhere.

From such resources comes victory. And, after that, assurance of new and improved sporting arms, in ample supply.

Savage Arms Corporation
Utica, N.Y.

ARMY E NAVY

"Proudly we hail—"

"SAVAGE" was among the first to receive the Army-Navy "E" for high achievement in war production. Proudly the cherished pennant flies above our Utica plant proclaiming, "Well done—DO MORE!"

SAVAGE

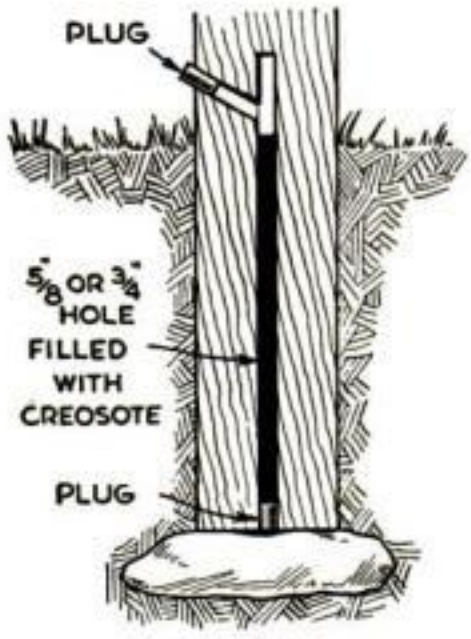
SAVAGE AUTOMATIC SHOTGUNS
Will resume their steady rise in popularity which, before the war, culminated in the introduction of the lightweight model for upland hunting.

(Continued from page 216)

happen if cardboard tags were used, especially when cables are pulled from the box.

The binding screws of three-way and four-way switches that must be removed for repair or replacement may be color-marked to match their corresponding leads. If colored pipe cleaners are not available, white cleaners may be dipped in colored paint to serve the same purpose.—J. MODROCH.

Internal Creosote Treatment Saves Posts from Termites



IN AREAS where termites are prevalent it is usually easier to keep them out of fence posts and other wood in contact with the ground than to get rid of them once they have established themselves. One protective method commonly used is the application of asphalt paint to the base of the post. Tests extending over three years in a heavily infected area indicate that the following method is definitely superior:

To prepare a post, a 5/8" or 3/4" hole is bored into the center of one end lengthwise from the bottom to a point that will be 2" or 3" above the ground line when the post is in place. This can be done readily with one of the long bits used by electricians. Above the ground line a hole is drilled from the side to meet the first hole as shown. The long hole is plugged tightly at the bottom with a wooden plug. Paint the lower end of the post with creosote before setting it.

After the posts are in the ground, the hole in the center is filled with creosote, or a mixture of half creosote and half kerosene. During the first summer this should be replenished about once a month so that the wood will become thoroughly impregnated. From then on a yearly filling will suffice. Plug the upper hole to keep out rain and snow.—HARRY W. DRYDEN.

Reversing Old Faucet Washer

WHEN a rubber faucet washer wears to the point that the faucet leaks, don't throw it away. If you turn it over so that the worn circular groove faces downward, the unused face of the washer will keep the faucet from leaking.—L. MCCANDLISH.

LT. RAWLINGSON'S

One Shot

IN GREECE, a weary British rearguard slogs over a bridge of the Corinth Canal. Engineers remain to lay demolition charges. Before they can be fired, German parachutists shower down, seize the bridge. Engineer Lt. Rawlingson escapes, hides in a hole. The Germans search frantically for the hidden TNT. Suddenly, Rawlingson spies one of the distant detonators—no larger than a cigarette, hanging by the connecting wire against the gray stone of the bridge. Raising his rifle, he sights carefully—fires! A deafening roar. Bridge and Germans fall, a tangled mass, into the Canal. The British trudge on toward their ships—*saved by a rifleman.* (This is a true story, except for the rifleman's name, from the September 1942 issue of The American Rifleman.)

EVER SINCE rifling turned guns into deadly precision instruments, the trained rifleman has been the backbone of the army.

Our own history, especially, has been the history of men who shot faster and straighter than their foes. But America is no longer "a nation of mar men"—*less than 2% of inductees know anythi about rifle arms.* That is why fire-arms manuf turer O. F. Mossberg & Sons, Inc. urges *all* own of .22 calibre rifles to . . .

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Christmas Photo-Card Contest Winner Chosen by Judges

THE winner of the Christmas photo-card contest (see P.S.M., Dec. '42, p. 145) and the $25 cash award is Richard Varian, of Brooklyn, N. Y.

Mr. Varian chose a literary motif for the subject of his greeting card. Carefully and beautifully lighted and with a well-subordinated background, the card was a combination of good photography, masterful composition, and appropriate holiday sentiment.

Although Mr. Varian's card was the best of the many submitted, there were several other entries the judges considered worthy of receiving an honorable mention in this contest. The contestants who submitted these cards are: Albert Smith, of Franklin, Pa.; E. J. Doran, of Bridgeport, Conn.; E. E. Blevins, of Memphis, Tenn.; Paul Karnov, of Chicago, Ill.; and Ottmar Goebel, of Los Angeles, Calif.

Grinding Old Files to Make Wood-Turning Tools

FILES are made from excellent steel, but it is neither safe nor wise to convert old ones into wood-turning tools unless the temper is properly drawn from them. One way to do this is to put the file on the grinding wheel and grind the teeth off, holding it against the wheel until the steel turns blue. Then let it cool slowly and it will be the proper temper for excellent cutting tools. Round files may be made into small gouges. Flat ones make good skew chisels, and the square ones, parting tools. This shop suggestion is worth remembering and applying these days when conservation of time and materials is so important.—J. J. EDWARDS.

Model Kits Are Discontinued for Duration of the War

BECAUSE of shortages of materials and other circumstances beyond our control, the manufacture of POPULAR SCIENCE construction kits has been discontinued for the duration of the war. Our blueprints, however, will remain available for the use of model builders who wish to assemble their own materials. Suitable materials can often be found in the home or school shop, and with some ingenuity it should be possible to build creditable models from the blueprints.

There's no short cut to the glorious ripeness you'll find in Briggs tobacco. It takes nothing less than cask-mellowing for long, slow years—longer than many costly blends receive. But it's *worth* it! For that's how Briggs develops its tender, rich flavor . . . its full-bodied, satisfying goodness . . . its savory, tantalizing aroma. Why not promote your pipe to Briggs *today?*

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RESULTS GUARANTEED!

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Cruising Sailboat, 19′ long, weighs 700 lb., Marconi sloop rig; can be used with 1 to 4 h.p. inboard or outboard motor, 400-401-402-403-404-R	2.00
Fisherman's Outboard Boat, 9′ 3″ or 11′ 6″ long, weighs 115 or 160 lb., for motors from 3 to 16 h.p., can also be rowed, 344-345-R	.75
Folding Wall Brackets (turned), Treble-Clef Bud Vase (metal or plastic), Vacuum Cleaner Attachment Rack, 408A	.25
Four-Leaf Card or Occasional Table, 239A	.25
Modernistic Folding Screens, 4 designs that require no turning, 91	.25
Perpetual Star Chart, 214	.25
Projector for Photo Prints and Pictures, 259A	.25
Sandpaper Cabinet, Saw Horse, Tool Rack, Hand-Screw Rack, and Machinist's Hand Vise, 368A	.25
Sectional Rowboat, 9′ 8″ long, two sections, weighs 60 lb., all-wood construction; can be used with small outboard motor, 340-341-R	.75
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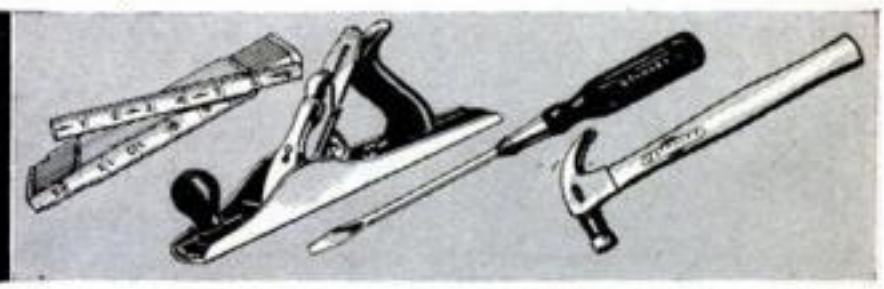

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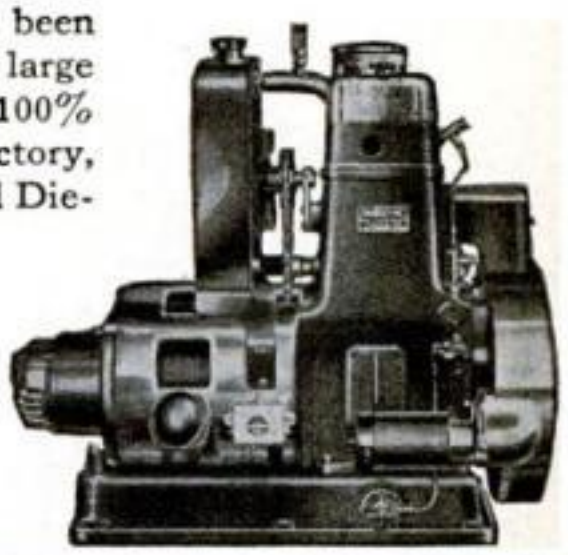

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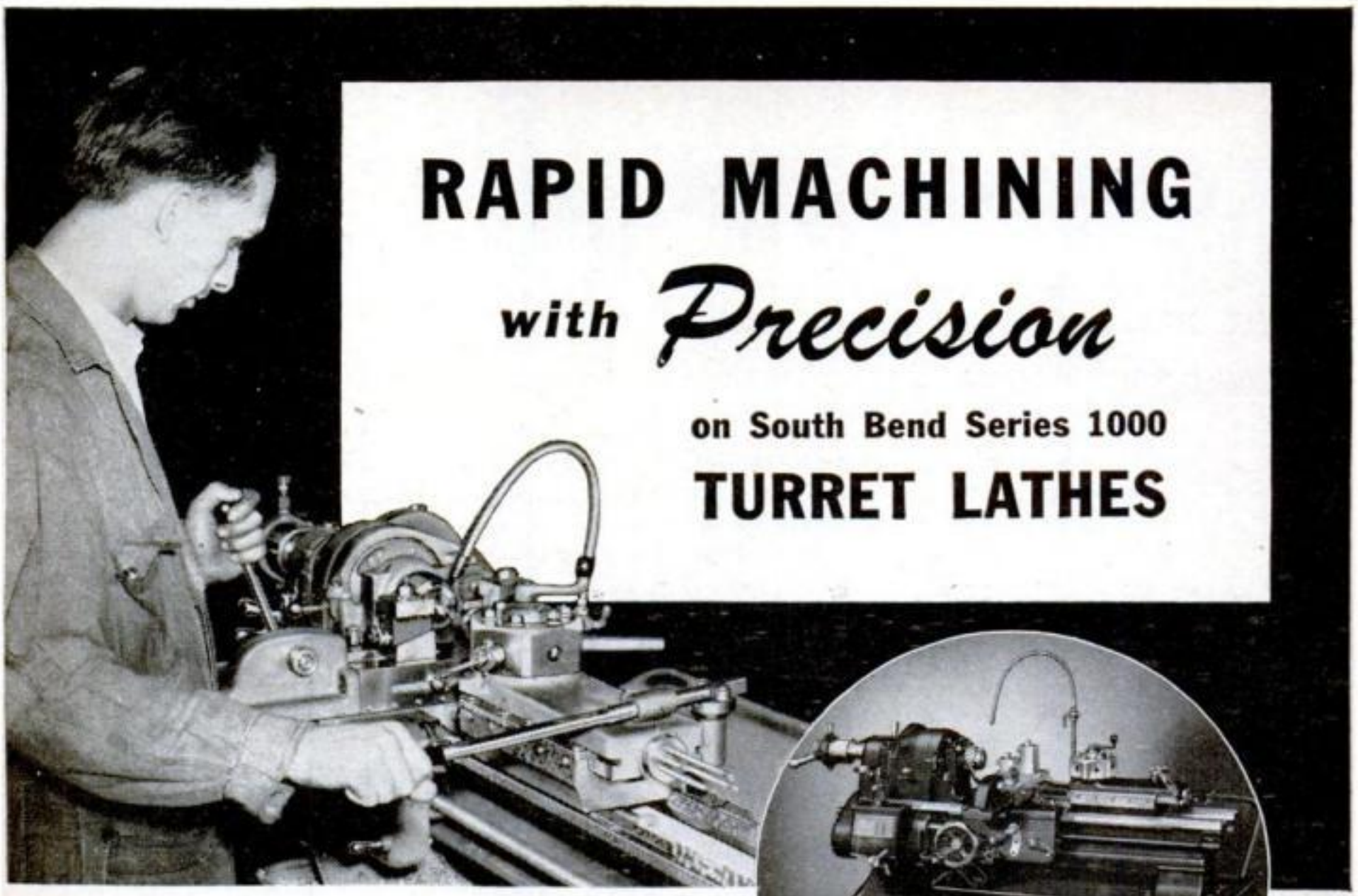

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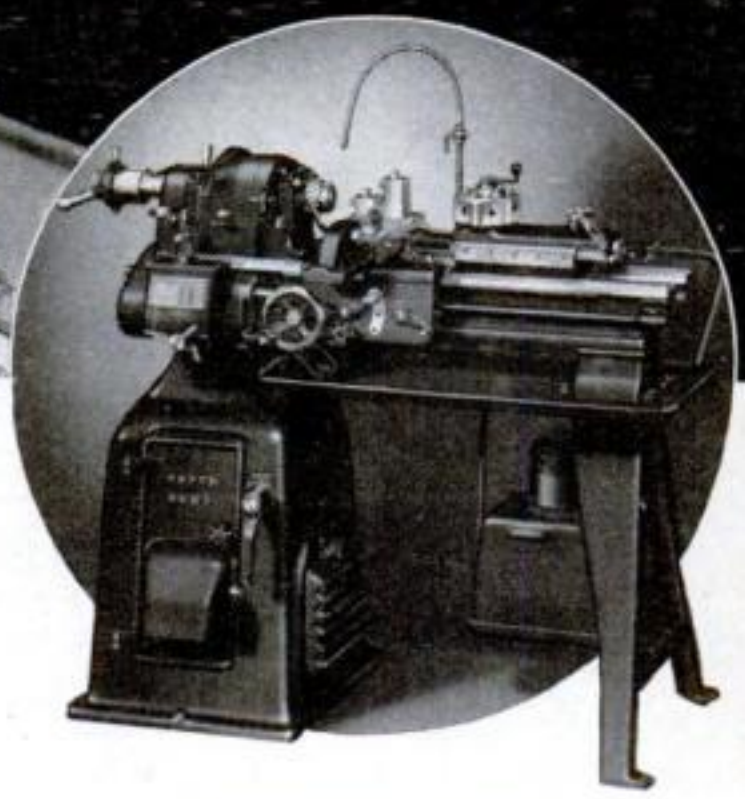

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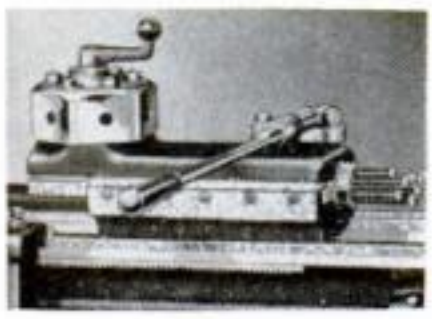

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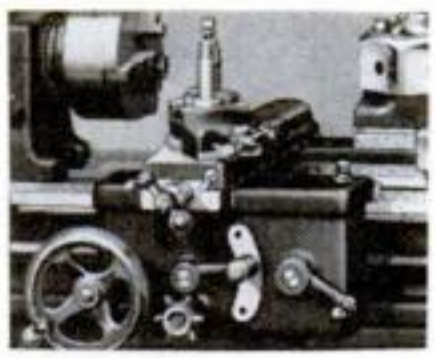

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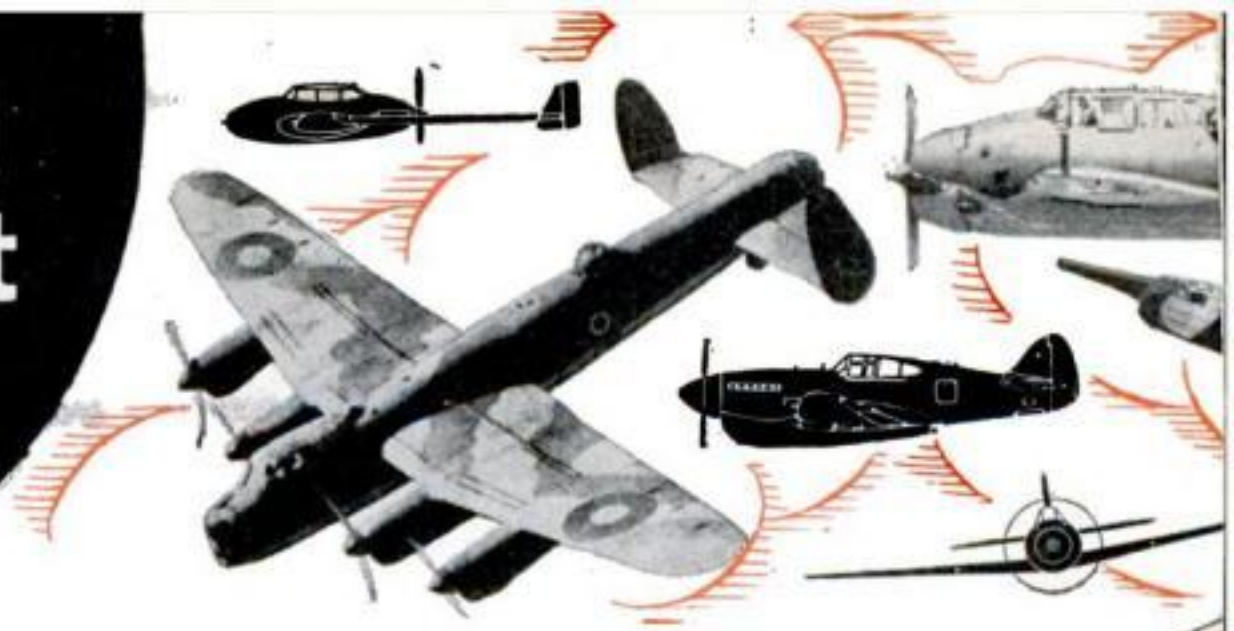

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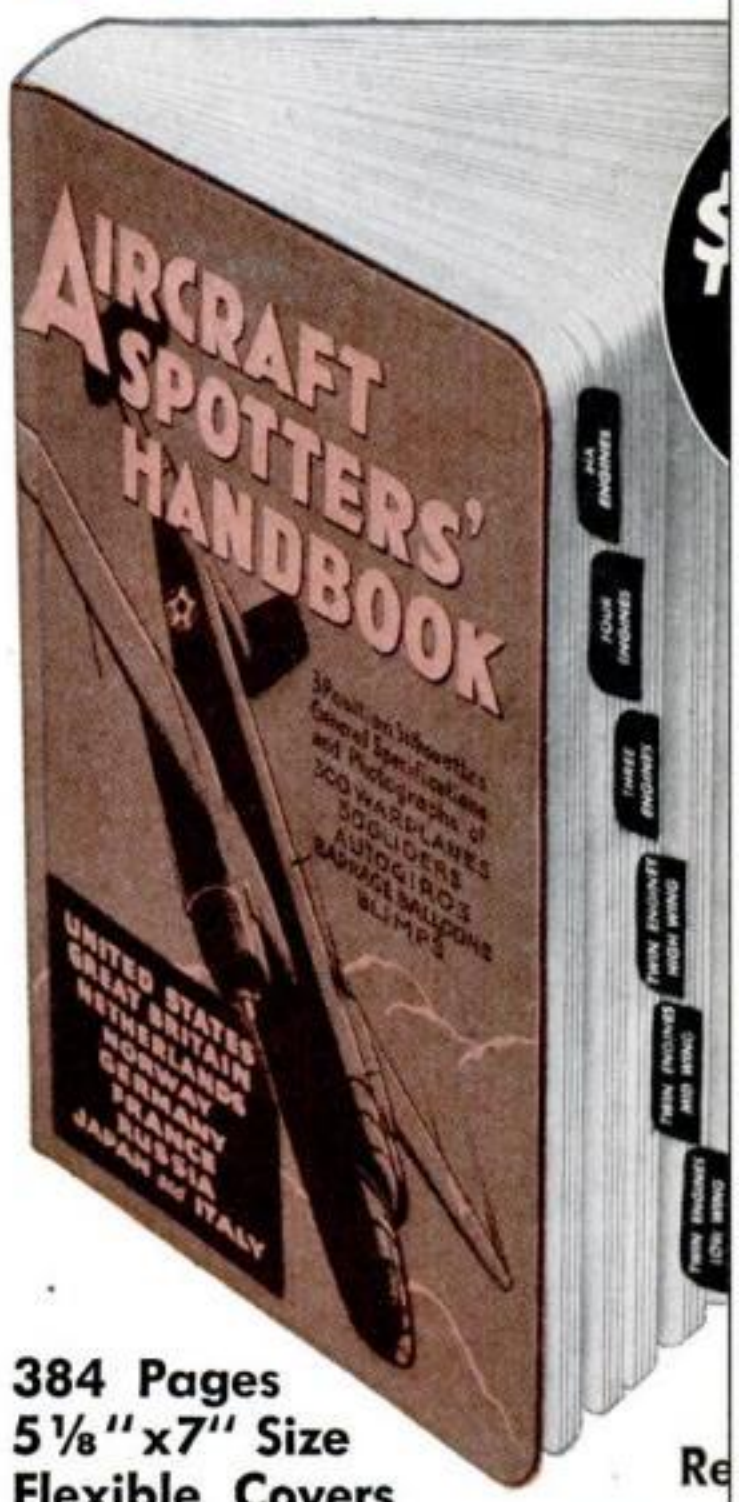

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